RECOGNIZING FACIAL EXPRESSIONS OF EMOTION IN INFANCY:

THE ROLE OF FACE FAMILIARITY

By

Kristina Safar

Bachelor of Arts in Psychology, York University

Toronto, Ontario, 2009

A thesis

presented to Ryerson University

in partial fulfillment of the requirements for the degree of

Master of Arts

in the program of

Psychology

Toronto, Ontario, Canada 2012

AUTHOR'S DECLARATION FOR ELECTRONIC SUBMISSION OF A THESIS

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I authorize Ryerson University to lend this thesis to other institutions or individuals for the purpose of scholarly research

I further authorize Ryerson University to reproduce this thesis by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research.

I understand that my thesis may be made electronically available to the public.

Abstract

Recognizing Facial Expressions of Emotion in Infancy: The Role of Face Familiarity

Kristina Safar

Master of Arts in the Program of Psychology, 2012

Ryerson University

Studies 1a and 1b examined 6-month-old infants' ability to generalize across three unfamiliar female identities to categorize a familiarized facial expression (happy or fearful) of one or varying intensity. Study 1c examined 6-month-old infants' ability to generalize across three familiar female identities (e.g., caregivers), to categorize a familiarized facial expression (happy or fearful) of one- intensity. Finally, Study 2 examined 8- and-9-month-old infants' ability to generalize across three unfamiliar female identities to categorize a familiarized facial expression (happy or fearful) of two-intensity. Results revealed the same pattern across all four studies; infants demonstrated significant novelty preferences when habituated to happy but not fearful facial expressions and looked longer toward fearful facial expressions overall during test. These studies augment previous literature by elucidating the time course by which infants are able to categorize and understand the emotional meaning of happy and fearful expressions when expressed by unfamiliar and familiar female identities.

Acknowledgements

There are many individuals that I would like thank for their time, and support in helping complete this project. First, I would like to thank my supervisor Dr. Margaret Moulson for her tremendous time, guidance, patience, support, and openness to new and challenging research ideas. Under her supervision, I have learned an abundance of knowledge and skills, not only necessary to undertake and successfully complete this project, but also for overall success in graduate school. Second, I would like to acknowledge all of the members of the BEE Lab for their hard work and assistance with the project. I truly appreciate the enthusiasm and dedicated help with participants and all other study related tasks. Third, I would like to thank all of the parents of infants who participated in the studies. I greatly appreciate your willingness to participate, time and interest in infant studies. Finally, I would like to recognize my family and friends for their support, and a special thank you to my partner Sebastian Pearson for all his help with the project and continuous support always.

Table of Contents

List of Tables

List of Figures

List of Appendices

Facial expressions of emotion convey an abundance of social information critical for effective communication with others (Bornstein & Arterberry, 2003). In infancy the exchange of facial expressions between infants and their caregivers promotes the development of emotion understanding (Pollak et al., 2002), secure attachment relationships (Laible & Thompson, 1998), emotion regulation (Fox, 1994), and more sophisticated social skills (Mumme, Fernald, & Herrera, 1966). Although an abundance of studies have examined infants' ability to recognize a variety of facial expressions, it still remains unclear when this ability becomes reliable. Specifically, there is a gap in the literature in our understanding of when infants can reliably recognize facial expressions of emotion in more demanding tasks, such as categorization paradigms. In categorization paradigms investigating the recognition of facial expressions, infants are required to generalize across different people posing the same facial expression in order to categorize the underlying emotion, and then discriminate between the categorized expression and a novel expression. To successfully interpret and convey social information it is imperative that infants recognize that a particular facial expression remains the same, no matter who expresses it (Bornstein & Arterberry, 2003).

The majority of infants are first exposed to exemplars of facial expressions through interactions with their caregivers (Kahana-Kalman & Walker-Andrews, 2001). Many studies have suggested that the quality of early infant-caregiver relationships influences recognition and understanding of emotion in later childhood (Laible & Thompson, 2008; Pollak et al., 2009; Steele et al., 1999). However, minimal research has examined the effect of person familiarity on infants' ability to recognize facial expressions of emotion (Barrera & Maurer, 1981; Kahana-

Kalman & Walker-Andrews, 2001; Walker-Andrews et al., 2011), and these studies have only considered infants' primary and secondary caregivers (Montague & Walker-Andrews, 2002). Additionally, these studies have failed to investigate recognition through the use of categorization paradigms.

The current studies will address these limitations within the literature. Results will add not only to our knowledge of emotion recognition in infancy, but also to our understanding of the development of later social abilities (e.g., emotion regulation and attachment relationships).

Theoretical Perspectives on Facial Expressions of Emotion

Discrepancy within the literature continues to exist as to what facial expressions reflect and express (Darwin, 1872/1998; Fiske, 1998; Scherer, 1992). Over a century ago, Darwin (1872/1998) proposed three principles, based on his observations of animals, which elucidated the origin of expressions and clarified what they might convey. Darwin's first principle, referred to as the principle of serviceable habits, suggested that expressions are caused by involuntary " serviceable habits." These habits arise from the frequent involuntary association between certain mind states and actions necessary for survival, and if expressed frequently caused physical changes to the nerve cells responsible for motion, sensation, and cognition. Further, these neural changes are inherited, reflecting the Lamarckian view of inheritance. Eventually, voluntarily engaging in a specific state of mind will automatically induce the associated action. Darwin's second principle, referred to as the principle of antithesis, suggested that all "serviceable habits" consisted of an involuntary opposite expression. Through the frequent expression of habits, these opposite expressions become custom and are inherited (e.g., when preparing to attack a stranger

a dog may assume an angry "serviceable habit;" however, upon realization that the stranger is his master will engage in an opposite expression [joy]) (Darwin, 1872/1998). Lastly, Darwin's third principle, referred to as the direct action of the excited nervous system on the body, suggests expressions are a function of the nervous system. Darwin proposed that when nerves become overly stimulated, an excess amount of energy is produced within the body. This energy is translated into an action or response representing an expression (e.g., trembling may be a result of experiencing fear) (Darwin, 1872/1998). Based on observations of different species, Darwin further proposed that expressions convey emotion; specifically, joy, fear, pain, and anger (see Chevalier-Skolnikoff, 2006). Darwin's principles encompassed his theory that, a) expressions represent an emotional inner mental state, which is imperative for effective communication within a species, b) expressions are hereditary and have progressed throughout evolution, and c) expressions play an important communicative role in human history and are imperative in facilitating survival (Darwin, 1872/1998; Hess & Thibault, 2009).

Darwin's principles of expressions of emotion have undergone criticism; nevertheless Darwin's work has greatly contributed to and has influenced more research within the field (Hess & Thibault, 2009). Inspired by Darwin's principles, Tinbergen's (1952) work examining animal populations proposed that expressions were a result of innate non-valuable actions, due to an over production of energy within the body, due to conflicting urges. Tinbergen stressed that these actions serve as social signals imperative for communication that have evolved over time (for a review see Izard, 1971). Other researchers adopting Darwin's principles of expressions proposed that expressions were initially expressed as impulses and urges by animals, then developed over

time into facial expressions of emotion in primates and humans as a result of their adaptive communicative function (Andrew, 1963; see Izard, 1971).

Various theories of the production of facial expressions in humans differ in their views of, 1) whether facial expressions are innate and universal; and 2) what facial expressions actually express (e.g., underlying emotion versus social signals) (Ekman, 1970; Fridlund, 1994; see Izard, 1997). One perspective, in accordance with the evolutionary theories described above, proposes that facial expressions in humans reflect innate basic emotions (Ekman, 1972; Izard, 1971). These facial expressions of emotion are thought to be universal in nature, in that they can be conveyed and recognized pan-culturally (Ekman, 1998, 1999; Ekman & Friesen, 1971; see Izard, 1997). Initial evidence for this theory originates from Darwin's research examining the universality of facial expressions (Darwin, 1872/1998; Ekman, 1998; 1999). Darwin (1872/1998) accumulated evidence in support of universal facial expressions of emotion by questioning British travellers and settlers from countries worldwide as to whether facial expressions were evident cross-culturally. Replies indicating that facial expressions were analogous across cultures provided evidence for universality (Ekman, 1999). Due to criticisms regarding small sample size, biased questioning, and interviews limited to British men, this research was later replicated and extended (Ekman, Sorenson, & Friesen, 1969).

Ekman and colleagues (Ekman, 1992a; for a review see Ekman, 1999) conceptualized the existence of six basic innate and universally recognized emotions, including happiness, surprise, fear, sadness, anger, and disgust/contempt, and conducted a number of studies in support of this perspective. Ekman, Sorenson, and Friesen (1969), showed photographs of these

six emotional facial expressions to participants in the United States, Japan, Brazil, New Guinea and Borneo. Participants were instructed to choose words from a list that best labeled each of the emotions. Results revealed that across countries participants similarly recognized these facial expressions. Izard (1971) conducted a similar study independently across additional nationalities (e.g., American, English, Japanese, African, German, Swedish, French, Swiss, and Greek) allowing participants to provide their own emotion label for each of the expressions. Findings indicated minimal variance between participants' responses in labeling emotional faces. In a subsequent study, Ekman & Friesen (1971) examined whether participants residing in remote New Guinea, completely isolated from Western culture, were able to recognize the six basic facial expressions of emotion. Results revealed significant recognition accuracy. A similar study was conducted shortly after (Ekman, 1972) in which participants in New Guinea posed facial expressions of emotion in response to emotional stories. Facial expressions were videotaped and shown to American participants, who were instructed to judge the emotions displayed. Results indicated significant recognition accuracy, providing greater support for the universality of facial expressions of emotion. Further evidence in support of this finding was provided by research indicating universal recognition of spontaneous facial expressions of emotion cross-culturally (i.e., Japanese and American populations) (Matsumoto & Ekman, 1989). Findings revealed a high correlation between Japanese and American participants' facial actions when posing spontaneous facial expressions of emotion (see Ekman, 1998).

Infant facial expressions have also provided some support for an innate and universal view of facial expressions of emotion (Camras et al., 1992; Izard & Malatesta, 1987; see Oster,

2005; Wolff, 1963). Izard and Malatesta (1987) proposed that particular facial expressions (e.g., smiles during sleep) in neonates and very young infants (birth to 2 months of age) reflect primitive reflex actions of the nervous system. Once the nervous system becomes more mature (starting at approximately 2 months of age), infant facial expressions start to reflect emotions. Infants at this age begin to produce the universal facial expressions of emotion that adults produce (Izard & Malatesta, 1987; see Oster, 2005). Research measuring the production of facial expressions in infancy has provided further support for universality (Camras et al., 1992; See Ekman, 1999). Camras et al. (1992) found similarities in facial actions produced by Japanese and American infants during arm restraint designed to elicit anger.

Contrary to Darwinian thought and theories of innateness and universality, there is an argument in favour of more cultural specificity in the production of facial expressions of emotion (see Ekman, 1989; see Izard, 1971; Kleinberg, 1940; Russell, 1994). Proponents of a culture-specific view of facial expressions have argued that variation exists in the use of facial expressions of emotion between different cultures. For example, smiling can signal joy in one culture and contempt in another (see Ekman, 1989). In response to these claims, Ekman (1972; Ekman, 1989; see Matsumoto, 1991), proposed the neurocultural theory of emotional expression, which retains the notion of universality of facial expressions, but also accounts for culture-specific variation. This theory (Ekman, 1972; 1989) suggests that prototypes of the six basic emotions are accessed from an innate "facial affect system," but then facial expressions are expressed contingent upon the social display rules inherent to specific cultures. In accordance with this theory, Ekman (1970; 1993) argues that different cultures will abstract and interpret

varying meanings from the same emotion-eliciting events, and depending on socially learned and appropriate behaviours in response to these events, facial expressions of emotion will vary between cultures. Further, the intensity of the six basic emotions may vary cross-culturally depending on culture-specific display rules (Ekman, 1987; Ekman, 1993; see Matsumoto, 1991). Thus, Ekman (1993) suggested that it might be beneficial to categorize different intensities of the same facial expression as belonging to the same family of emotion.

Although Ekman's neurocultural theory acknowledges some cultural variability in the expression of emotions, it still retains the idea that facial expressions reflect underlying universal emotions. An alternate perspective on what facial expressions reflect is proposed by behavioural ecology theory (Fridlund, 1994; Fridlund, 1997; see Horstmann, 2003). Fridlund (1994) proposed that facial expressions convey strictly social messages, rather than underlying universal emotions. It is argued that facial expressions are innate and evolved due to their important communicative function. Specifically, facial expressions convey information regarding the expresser's current and future behavioural actions; during our evolutionary history, this information was necessary for our survival during potentially hostile encounters with others and effective communication during social interactions. It is further argued that facial expressions convey social information about the behavioural action that the recipient should take. Thus, facial expressions that convey social information that benefit the expresser and the recipient in a social interaction are advantageous and will evolve (Fridlund, 1994; see Horstmann, 2003).

In contrast, an appraisal perspective conceptualizes facial expressions as conveying underlying emotions that are appropriate for specific social situations based on the expresser's

appraisal of a particular situation (see Roseman & Smith, 2001). Dissimilar to the Darwinian perspective (1872/1998), the appraisal perspective proposes that facial expressions of emotion in response to different social events are not elicited in an automatic stimulus-response fashion and are not universal. Rather, facial expressions vary depending on a person's appraisal of different social situations. This theory accounts for the cross-cultural variation of facial expressions by arguing that facial expressions are dependent on a particular culture's display rules or social norms (see Ekman, 1989). Different cultures may interpret or appraise social situations according to learned display rules, and therefore facial expressions of emotion expressed in different social scenarios may vary between cultures (see Roseman & Smith, 2001).

Recognizing Facial Expressions of Emotion: Dimensions and Categories

Theories underlying the recognition or identification of facial expressions of emotion are also debated within the literature (see Aldophs, 2002). On one side of the debate, it is proposed that facial expressions are recognized as dimensions along a continuum (see Izard, 1971, Russell, 1980; Schlosberg, 1952; 1954), and on the other side of the debate, it is proposed that facial expressions are recognized as discrete and independent categories (Ekman, 1992b).

Evidence supporting recognition along dimensions is provided by research indicating that individuals tend to misjudge the emotion depicted by different facial expressions in a systematic manner (see Adolphs, 2002; Albeson & Sermat, 1962; Schlosberg; 1952; 1954). Woodsworth (1938; see Izard, 1971) found that individuals are likely to err by misidentifying facial expressions of emotion as the adjacent expression when conceptualized along a linear continuum. Schlosberg (1952; 1954) then observed that individuals frequently confused

expressions at opposite ends of the proposed linear continuum, which led him to propose a multi-dimensional circular model that may better represent individuals' recognition of facial expressions of emotion. Schlosberg's (1954; see Izard, 1971) circular model consists of three dimensions along x-, y- and z-axes: Pleasant-Unpleasant across the x-axis, Accepting-Rejecting across the y-axis, and Tension-Sleep across the z-axis. The dimension Pleasant-Unpleasant represents positive versus negative expressions of emotion (i.e., happiness vs. anger), the dimension Accepting-Rejecting represents approach versus avoidance expressions of emotion (i.e., surprise vs. contempt) and the Tension-Sleep dimension represents the intensity of expressions of emotion (Schlosberg, 1952; 1954). Facial expressions of emotion are positioned in the model according to subjects' ratings of each expression on a Likert scale from 1-9 for each of the three dimensions (e.g., Pleasant 1 to Unpleasant 9). Facial expressions of emotion represented in the model form a circular cluster around the perimeter, distal from the centre of the three axes (Russell, 1980; Schlosberg, 1952; 1954).

Schlosberg's (1952; 1954) work was effectively validated through the use of multidimensional scaling (MDS) (Abelson & Sermat, 1962). MDS is a mathematical approach to modeling the recognition of facial expressions of emotion along multiple dimensions (see Adolphs, 2002). Specifically, MDS represents individuals' judgments of dissimilarity between facial expressions of emotion mapped along multiple dimensions in space. In other words, two emotions appearing closer in space are greater in similarity (see Adolphs, 2002; Bimler & Kirklan, 1997). Abelson and Sermat (1962) applied MDS to participants' judgments of the dissimilarity between pairs of facial expressions of emotion on a Likert scale (i.e., very similar 1

to dissimilar 9). Findings revealed overlap between the Accepting-Rejecting dimension and the Tension-Sleep dimension, and so the former dimension was determined unnecessary. Despite this overlap, Schlosberg's overall dimensional model was validated by MDS. Similarly, Russell and Bullok (1980) used MDS to determine how adults and 2, 3, and 4-year-old preschool children's recognition and identification of facial expressions of emotion were best represented dimensionally. Findings suggested that facial expressions were best spatially represented by a two-dimensional model, consisting of a Pleasant-Unpleasant dimension across the x-axis, and a High-Low Arousal dimension across the y-axis.

In contrast to dimensional theories, categorical theories of facial expressions argue that emotions are recognized discretely and independently (see Brosch, Pourtois, & Sander, 2009). As discussed in the previous section, evidence exists in support of basic emotion categories as innate and universally recognized (Ekman, 1972; Izard, 1971). Alternative evidence also suggests that social and learned factors affect the formation of emotional categories. For example, Mervis and Rosch (1981) proposed that emotion categories might be formed based on the association between particular events, subjective affective states, and facial expressions of emotion (e.g., frightening situation, trembling, and a fearful facial expression combine to form the emotion category "fear") (see Brosch, Pourtois, & Sander, 2009). These underlying emotion categories then provide the basis for recognizing facial expressions of emotion categorically.

Many studies have examined individuals' ability to categorize facial expressions of emotion (Calder, 1996; Etcoff & Magee, 1992;Young et al., 1997). Etcoff and Magee (1992) used drawings of morphed facial expressions to examine whether individuals recognize facial

expressions of emotion categorically. Several sets of morphed facial expressions were created: angry to sad, angry to afraid, angry to disgusted, happy to sad, happy to neutral, sad to neutral, happy to surprised, and surprised to afraid. Each step along a morphed continuum physically varied by a constant amount. Participants performed discrimination and identification tasks. Results revealed that participants recognized facial expressions categorically. Specifically, they recognized facial expressions more accurately when the expression bordered a new emotion category along the string (e.g., happy bordering surprised), as compared to when the expression was within the same emotion category along the string (e.g., happy bordering happy). In other words, results indicated that individuals discriminated and recognized expressions of emotion with greater accuracy when expressions belonged to different emotion categories as compared to the same emotion category. A later study yielded the same findings using morphed photographs of facial expressions (Calder et al., 1996).

Thus far, this introduction has predominately focused on theories and empirical research investigating the origin of facial expressions of emotion, what facial expressions convey and reflect, and how facial expressions of emotion are perceived and recognized. However, to gain a comprehensive understanding of the above, it is necessary to examine research investigating the development of facial expressions of emotion in infancy. There is a significant amount of research that sheds light on infants' abilities to discriminate and recognize facial expressions, when in infancy these abilities are achieved, and what factors influence the discrimination and recognition of facial expressions of emotion. The remainder of this review will focus on these topics.

Importance of Facial Expressions of Emotion in Infancy

The ability to perceive, recognize, and discriminate among facial expressions of emotion in infancy plays a critical role in the development of communication, emotion regulation, attachment, and social learning (Cohen et al., 1991; Fox, 1994; Bornstein & Arterberry, 2003; Montague & Walker-Andrews, 2002; Walker-Andrews & Dickson, 1997). Facial expressions are one of the first ways by which infants can interact and communicate with their caregivers. As early as 2 to 3 months of age infants demonstrate the ability to recognize caregiver facial expressions and respond through the use of their own facial expressions (Kahana-Kalman & Walker-Andrews, 2001). Studies have shown that neonates and young infants (e.g., 3 months) attend longer to their mothers' happy faces and positive facial expressions than their negative expressions (Bornstein & Arterberry, 2003; Farroni et al., 2007; Kahana-Kalman & Walker-Andrews, 2001) and respond in a more positive manner to positive versus negative facial expressions. This positive interchange of emotion serves to establish secure attachment and positive infant-caregiver interactions very early in life (Bornstein & Arterberry, 2003). It has been suggested that infants who demonstrate insecure attachment patterns at 1 year of age show difficulty recognizing facial expressions of emotion later in childhood (Steele et al., 1999). Further, physically abused and neglected children, who are at risk for developing insecure attachment patterns (Lyons-Ruth et al., 1987), show deficits in their recognition of facial expressions (Pollak et al., 2000).

It has also been suggested that the recognition of facial expressions allows infants to attend to their caregiver's feelings and intentions, thereby allowing them to predict specific

caregiver behaviours so that they may regulate their own internal states and respond accordingly (Haviland & Lelwica, 1987; Kahana-Kalman & Walker-Andrews, 2001). The recognition of facial expressions is the first step towards developing knowledge about the emotional states and intentions of others, and eventually acquiring the ability to infer the emotional states of others and engage in social referencing (Haviland & Lelwica, 1987; Walker-Andrews & Dickson, 1997). By 10 to 13 months of age infants reference their caregivers in novel situations, and appear to alter their approach/avoidance behaviour according to caregivers' happy and fearful facial expressions during the presentation of novel toys (Walden & Ogan, 1988). In sum, evidence suggests that understanding the perception and recognition of facial expressions of emotion in infancy is vital to understanding later socio-emotional processes.

Discrimination Abilities in Infancy

Although an infant's ability to recognize and discriminate between different expressions of emotion is fundamental to the development of later social abilities, it remains unclear at what age infants are able to demonstrate this ability reliably. A variety of paradigms are used within the literature to examine infants' ability to discriminate between facial expressions of emotion (Farroni et al., 2007; Nelson, Morse, & Leavitt, 1979). A visual-paired comparison paradigm is commonly used to test discrimination between two facial expressions of emotion in infancy. The standard version of the task involves a familiarization phase and a test phase. First, the infant is familiarized to a series of identical stimuli (e.g., one person posing a happy facial expression) presented for a set amount of time, and then tested on this familiarized facial expression (e.g.,

happy) and a novel facial expression (e.g., sad) presented side-by-side. A novelty preference (i.e., longer looking at the novel versus the familiar stimulus during test, Fantz, 1958) reflects discrimination of the familiar and novel expression. A spontaneous preference task is also frequently used to examine infant discrimination abilities. The task typically consists of presenting an infant with a series of paired facial expressions (e.g., happy and sad facial expressions) presented side-by-side and measuring the amount of time the infant looks at one facial expression (e.g., happy) compared to the other facial expression (e.g., sad) across trials. A spontaneous preference (i.e., longer looking to one facial expression over the other) indicates both the ability to discriminate between the expressions and a preference for one expression over the other. Finally, habituation paradigms are an established method of investigating the discrimination of facial expressions in infancy. Similar to the visual-paired comparison procedure, the habituation paradigm consists of two parts, a) a habituation phase, in which the infant is presented with one repeated facial expression (e.g., happy), and b) a test phase, in which the infant is presented with the familiarized facial expression (e.g., happy) and a novel facial expression (e.g., sad). During the habituation phase the infant views the habituation stimulus repeatedly until they reach a particular threshold (usually, less than 50% looking of the first or longest three trials), after which the test phase begins. A novelty preference indicates discrimination of the familiar and novel expressions (Horrowitz, 1974).

Research has shown that shortly after birth, neonates imitate and can discriminate between happy, sad, and surprised facial expressions when posed by a live model (Field, Woodson, Greenberg, & Cohen, 1982; Field et al., 1983). A later study found that neonates

could discriminate between fearful and happy facial expressions, showing a significant visual preference for the happy expression as compared to the fearful expression. However, the same study failed to find any significant differences in neonates' preferences for neutral versus fearful expressions (Farroni, Menon, Rigato, & Johnson, 2007). This preference for happy facial expressions may be due to disproportionate exposure to happy expressions as compared to other expressions over the first few days of life. This emphasizes the role that experience may play in the development of emotion recognition (Farroni, Menon, Rigato, & Johnson, 2007). Haviland and Lelwica (1987) found that 10-week-old infants demonstrated discrimination between the live presentation of joy, anger, and sad facial expressions by their mothers. Using static photographs as stimuli, Barrera and Maurer (1981) found that 3-month-old infants were able to discriminate between happy and sad facial expressions in a habituation paradigm. Young-Bowne, Rosenfeld, and Horowitz (1977) found that 3-month-old infants discriminate between happy and surprised facial expressions, and sad and surprised facial expressions; however, order effects were present in infants' ability to discriminate between the latter two expressions. Specifically, 3-month-olds demonstrated discrimination between sad and surprised facial expressions only when first familiarized to the sad expression (and not when first familiarized to surprised). These order effects were suggested to be due to a general difficulty to discriminate between the sad and the surprised expressions (Young-Browne, Rosenfeld, & Horowitz, 1977). LaBarbera and colleagues (1976) examined infants visual responses to joy, neutral and angry facial expressions when posed by a static male model. It was found that 4- and 6-month-old infants demonstrated longer looking time towards joy as compared to neutral and angry expressions.

Do Young Infants Recognize Emotion?

It is clear that young infants can discriminate between certain facial expressions of emotion; less certain is whether they are able to recognize or extract the emotional meaning underlying facial expressions of emotion (Caron, Caron, & Myers, 1982; 1985). Walker-Andrews (1997) suggests that due to limitations in early verbal and cognitive abilities, researchers should not assume that young infants are able to understand the underlying emotional meaning of others' facial expressions. She proposes that infants' ability to recognize the underlying meaning of facial expressions of emotion develops quickly over the first year of life and progresses through three stages: detection, discrimination, and recognition. Accounting for neonates and very young infants' limitations in visual processing (Caron et al., 1973), Walker-Andrews (1997) suggests that early in life infants detect minimal sensory information that may represent emotional information (e.g., high contrast, low spatial information). A few months later, infants demonstrate discrimination between facial expressions of emotion. In other words, they can detect differences between different expressions (perhaps though the use of isolated facial features). Finally, by approximately 7 months of age infants begin to show recognition of facial expressions of emotion, in that they understand the meaning of the emotion and respond accordingly (e.g., social referencing).

Limitations in Young Infants' Ability to Recognize Facial Expressions

Although it is surprising that infants do not attend to the emotional significance of facial expressions until the second half of the first year, limitations in the early visual system and changes in general face processing may place restrictions on young infants' ability to understand

the underlying meaning of emotions (Cashon & Cohen, 2004; Cohen & Cashon, 2001; Kestenbaum & Nelson, 1990). It has been suggested that very young infants (e.g., 0 to 3 months of age) may possess inadequate visual acuity necessary for recognition (Atkinson, Braddick, & Moar, 1977; Caron et al., 1973; Maurer & Salapatek, 1976). Further, from birth to approximately 4 months of age infants predominantly attend to the eyes and the outer versus inner structures of the face (Caron et al., 1973). Another limitation of the young infant's visual system is their facial scanning ability (Maurer & Salapatek, 1976; Nelson, 1987). Maurer and Salapatek (1976) found that when scanning live presentations of faces, 1- month-old infants tended to fixate on the outer versus inner areas of the face.

Changes in infants' perception of faces may also explain why young infants experience difficulty recognizing the underlying emotional meaning of facial expressions (Cashon & Cohen, 2004; Kestenbaum & Nelson, 1990; Schwarzer, Zauner & Jovanic, 2007). Specifically, findings have revealed a gradual shift from featural to configural processing of faces and facial expressions of emotion (Cashon & Cohen, 2004; Cohen & Cashon, 2001; Schwarzer, Zauner & Jovanic, 2007). For example, research has revealed that 4-month-old infants perceive faces in a featural manner (e.g., focused on individual features, like the eyes and the mouth, rather than the configuration of these features); however, 10-month-old infants demonstrated configural face processing (e.g., being sensitive to the relations between the internal features of the face, Schwarzer, Zauner & Jovanic, 2007). And Cashon and Cohen (2001) have found that by 7 months, infants engage in configural processing of faces. Configural processing at 7 months of age appears to extend to processing facial expressions, because Kestenbaum and Nelson (1990)

found that 7-month-olds engage in configural processing of happy facial expressions. This evidence suggests that the onset of configural face processing in the second half of the first year may facilitate the recognition of the underlying affective meaning of facial expressions

Categorizing Facial Expressions of Emotion in Infancy

Considering limitations in visual perception and a preference to attend to featural rather than configural information early in life, the paradigms that are often used to investigate infant recognition (i.e., discrimination of static expressions posed by a single model) may be problematic. It is possible that discrimination in these paradigms may have been based on distinctive invariant features of the single model's face, rather than the expression itself (Caron, Caron, & Myers, 1982). For example, it is possible that young infants discriminate between happy and surprised facial expressions based on the presence of teeth, and have no appreciation of the underlying signal values of the expressions. Categorization paradigms, which investigate infants' ability to categorize the same facial expression posed by multiple individuals, control for discrimination based on invariant features of a single model's face. By exposing infants to multiple individuals expressing the same emotion, infants must detect the similarity in the overall posed expression despite variations in the individuals' faces. Thus, categorization paradigms may tap the actual recognition of emotion better than simple discrimination paradigms (Caron, Caron, & Myers, 1982). Furthermore, in order for the infant to use facial expressions to interpret and convey social information, the infant must have the ability to recognize that the meaning of a facial expression remains constant across identity (Bornstein & Arterberry, 2003). Previous studies have used this paradigm to investigate facial emotion recognition in infancy. Caron,

Caron, and Myers (1982) habituated one group of 4-, 5.5- and 7-month-old infants to four different models posing happy or surprised facial expressions and another group of 4-, 5.5- and 7-month-old infants to a single model posing happy or surprised facial expressions. During the test phase, both groups were shown a model posing the familiar expression and a novel expression. In the categorization condition, only 7-month-old infants discriminated between happy and surprised expressions. In contrast, in the single-model condition infants at all three ages demonstrated discrimination. These results strongly suggest that infants in the single-model condition may have based discrimination on isolated features of the single model's face. This casts doubt upon the conclusions about facial emotion recognition drawn from studies that did not use categorization paradigms.

Research has suggested that by 7 months of age infants perceive facial expressions of emotion categorically (de Gelder, Teunisse, & Benson, 1997; Kotsoni, de Haan, & Johnson, 2001; Leppanen et al., 2009). Kotsoni, de Haan, & Johnson (2001) examined the categorization ability of 7-month-old infants through the use of a visual preference task and a familiarization task. Stimuli consisted of a string of morphed photographs ranging from happy to fearful, with each photograph varying by set physical amounts (e.g., stimuli ranged from 100 percent happy and 0 percent fear to 100 percent fear and 0 happy). Results of the visual preference task indicated that infants discriminated between the pairs of expressions when expressions crossed category boundaries (happy vs. fear) but did not discriminate between pairs of expressions that were within the same category (happy vs. happy). Similar results were found in the familiarization task. Results revealed that infants first familiarized to a happy facial expression

successfully discriminated between the happy facial expression and a novel facial expression only when the novel facial expression belonged to a fearful category of emotion (i.e., crossed the category border). However, this effect was not replicated when infants were first familiarized to fearful expressions. Similarly, Leppanen and colleagues (2009) examined infants' categorical perception of facial expressions of emotion through the use of a habituation task and event-related potentials (ERPs). Infants were habituated to either a happy or sad expression and tested using a visual- paired comparison task. In the visual- paired comparison, pairs consisted of the familiarized expression and either a between-category or within-category expression. Following the visual- paired comparison task, infants were shown a series of morphed expressions (happy to sad varying in 10 percent increments), and ERPs were recorded. Similar to previous work (Kotsoni, de Haan, & Johnson, 2001) results indicated that during the visual-paired comparison task, infants successfully discriminated between the familiar and novel expressions only in the between-category condition. ERP results revealed differences in neural components in response to between- versus within-category expressions, suggesting a neural basis for the formation of emotion categories in infancy.

Studies using the categorization paradigm have commonly found that the recognition of facial expressions across identity is fairly consistent at approximately 7 months of age (Ludemann, 1991; Ludemann & Nelson, 1988; Nelson & Dolgin, 1985; Nelson, Morse, & Leavitt, 1979). Nelson, Morse, and Leavitt (1979) familiarized 7-month-old infants to two different models posing either a happy or fear facial expression and tested them on a third model posing the familiar and a novel expression. They found that 7-month-olds could categorize

expressions, generalize across the different models' identities and discriminate the happy expression from the fearful expression when familiarized to the happy expression only (when infants were familiarized to the fearful expression, they did not demonstrate discrimination during the test phase). It was suggested that this order effect occurred due to a lack of familiarity or defensive response to the fearful expression, which made it harder for infants to become familiarized to the fearful expression during habituation. Similarly, Nelson and Dolgin (1985) found that 7-month-old infants categorized happy and fearful expressions, generalized across four unfamiliar models and discriminated happy from fearful; however, this was only the case when happy was the familiar expression. They suggested that infants might show a tendency to look at the fearful face when given the option to look at a fearful expression and happy expression posed side-by-side. Ludemann and Nelson (1988) suggested that the failure to discriminate fear from happy and surprised expressions might be due to 7-month-olds' lack of familiarity with the expression fear relative to happy or surprise. It is currently unclear which of these explanations of 7-month-olds' lack of ability to categorize fearful facial expressions is correct.

Considering the adaptive and social relevance of the ability to generalize across multiple persons in order to categorize the same facial expression of emotion, it is surprising that limited research has examined this ability in infants younger than 7 months of age. The youngest this ability has been found at is 5 months of age. In a slightly more demanding categorization task, Bornstein and Arterberry (2003) examined 5-month-old infants' ability to generalize across four different models in order to categorize different intensities of a happy facial expression, then

discriminate between a new model posing a novel smile intensity and the new model posing a novel fearful expression. The use of different intensities of emotional expressions assured that infants were not relying on isolated features of an expression (e.g., "toothiness" in happy expressions) as the basis for discrimination (Bornstein & Arterberry, 2003; Ludemann & Nelson, 1988). Results revealed that infants looked longer at the fearful expression during the discrimination phase, which indicates that they were able to generalize across the multiple models and categorize the different intensities of smiling. No studies have examined infants' ability to categorize fearful facial expressions and discriminate fearful from happy facial expressions younger than 7 months of age.

Recognizing Facial Expressions of Emotion in Infancy: Why is Familiarity Important?

Most infants are first introduced to facial expressions of emotion through exposure and interaction with caregivers within the family context, and are constantly exposed to exemplars of facial expressions by caregivers (Kahana-Kalman & Walker-Andrews, 2001). Many studies have suggested that increased perceptual experience with different exemplars of facial expressions facilitates recognition accuracy and emotion understanding (see Nelson, 1987; 2001). It has also been proposed that the quality of infant-caregiver relationships may lead to gains in perceptual experience with facial expressions (Laible & Thompson, 1998; Pollak et al., 2009). The following sections will focus on the possible role that early experience with caregivers and facial expressions plays in infants' ability to recognize facial expressions of emotion.

Evidence from attachment research. As mentioned earlier, the exchange of positive facial expressions of emotion between infants and caregivers is imperative for the development

of secure attachment relationships (Bowlby, 1969/1982; Laible & Thompson, 1998; Steele, Steele & Croft, 2008). Bowlby (1969/1982) emphasized the role that dependable and responsive infant-caregiver relationships play in forming infants' positive concepts of the self and primary caregiver. These relationships are internalized and mentally represented as "internal working models." Primary caregivers who are dependable, attentive, and responsive to their infants' needs foster positive and competent working models. These positive internal representations enable infants to successfully predict caregiver behaviours and respond accordingly, which serves as a foundation for the development of secure attachment relationships. Many studies have suggested that infants who have secure attachment relationships tend to be socially competent later in life (Laible & Thompson, 1998; Matas, Arend, Sroufe, 1978). Matas, Arend, and Sroufe (1978) found that by 2 years of age, infants who have secure attachment relationships with their caregivers tend to show greater self-esteem, confidence, and positive social skills (e.g., cooperation) when interacting with others, compared to insecurely attached infants. With regards to understanding emotion, it has been proposed that caregivers of securely attached infants engage in frequent interactions with their infants and demonstrate a copious array of facial expression exemplars during these interactions (see Laible & Thompson, 1998; Steele, Steele & Croft, 2008). Thus, securely attached infants may encounter a wider range of facial expression exemplars than insecurely attached infants, which may facilitate understanding of emotion (see Laible & Thompson, 1998). Indeed, Laible and Thompson (1998) found that secure infant-caregiver attachment relationships predicted increased emotional understanding in preschool children. And Steele, et al. (1999) found that infant-caregiver attachment security at 1 year of age

was a significant predictor of basic and more complex (i.e., mixed emotions such as disappointment) emotion understanding at 6 years of age. Steele, Steele and Croft (2008) later extended these results, revealing that infant-caregiver attachment security at 1 year of age was positively associated with an understanding of basic and complex emotion at 11 years of age.

Evidence from early adverse rearing environments. In accordance with research suggesting the importance of positive infant-caregiver interactions for the development of emotional understanding, studies of children in adverse rearing environments have revealed deficits in emotion recognition (Moulson et al., 2009, Pollak et al., 2000). Wismer Fries and Pollak (2004) found that 4.5-year-old children who were previously institutionalized in Eastern European orphanages demonstrated poorer recognition of happy, sad, angry, and fearful expressions, and more difficulty correctly matching these expressions to emotional scenarios, as compared to children reared by their biological parents. Moulson and colleagues (2009) examined neural processing of facial expressions through the use of ERPs in children residing in institutions in Romania, children previously residing in institutions in Romania and placed into foster care, and never-institutionalized children. Children were assessed at baseline (6 to 30 months), 30 months, and 42 months. Findings revealed attenuated amplitude and latency of the P1, N170 and P400 components over the occipital area of the brain in response to viewing happy, sad, angry and fearful facial expressions, as compared to never-institutionalized children at each of the three assessments. This finding was suggested to reflect "cortical hypoarousal" in response to facial emotion, which suggests that children reared in institutions demonstrate some impairment in emotion processing evident at the neural level. This atypical emotion recognition

in institutionalized children may be due to insufficient caregiving, and/or inconsistent caregiving resulting in insecure attachment relationships (Zeanah et al., 2005). However, it should be noted that despite this neural difference, children's ability to discriminate facial expressions behaviourally did not differ significantly between the institutionalized and never-institutionalized children (Jeon et al., 2010).

Many studies investigating the influence of child abuse and neglect on emotion understanding have also shed light on the importance of the early rearing context to the development of facial emotion recognition (Pollak et al., 2000; Pollak et al., 2009; Pollak & Kistler. 2002; Pollak & Sinha, 2002). Studies have suggested that children suffering from maltreatment experience greater incidences of negative facial expressions as compared to positive expressions. Further, it is suggested that maltreating caregivers tend to isolate their families from other people, decreasing the opportunity for maltreated children to learn about facial expressions of emotion through other social interactions. Thus, these children may not encounter a full array of facial expression exemplars as compared to non-maltreated children (see Pollak & Sinha, 2002). Pollak and colleagues (2000) found that neglected children demonstrated poor recognition abilities for angry, disgust, fear, happy, and sad expressions, and perceived few differences between facial expressions (specifically sad and happy expressions) in comparison to abused and non-maltreated children. Moreover, Pollak and colleagues (2009) found that 9-year old children reared in abusive families demonstrated heightened sensitivity in their ability to recognize anger when presented with a series of facial expressions ranging in intensity (e.g., neutral to very angry) as compared to children raised in non-abusive households.

The Role of Familiarity in Discriminating and Recognizing Facial Expressions of Emotion

It is evident that early experiences in the caregiving context affect the development of facial emotion recognition. Thus, it is surprising that few studies exist examining infants' ability to recognize facial expressions when posed by their caregivers as compared to strangers. Barrera and Maurer (1981) demonstrated that a greater number of 3-month-old infants demonstrated discrimination between smiling and frowning faces when shown static pictures of their mothers versus static faces of models. More recent research has focused on infants' ability to discriminate between facial expressions posed by infants' mothers and fathers in live multi-modal presentations (Kahana-Kalman & Walker-Andrews, 2001; Montague & Walker-Andrews, 2002). It has been suggested that infants may be more sensitive to expressions posed by their caregivers rather than strangers (Montague & Walker-Andrews, 2002), and therefore, that the discrimination of facial expressions might be achievable at an earlier age than has previously been demonstrated when expressions are posed by caregivers. Walker-Andrews and colleagues have examined 3.5-month-old infants' ability to match facial and vocal expressions of emotion, which is taken as an indication of emotion recognition. They found that 3.5-month-olds demonstrated the ability to match facial and vocal expressions when their mothers presented the expressions, but not when their fathers or an unfamiliar female presented the expressions. These results were interpreted to suggest that increased exposure to caregiver expressions and enhanced attention to caregiver expressions of emotions as compared to unfamiliar persons might facilitate early sensitivity to maternal facial expressions. Specifically, infants may be greater attuned to their caregivers' expressions because they may be relevant indicators of the quality of caregiver

relationships, thus allowing infants to anticipate caregiver behaviour (Kahana-Kalman & Walker-Andrews, 2001).

Recently, Walker-Andrews and colleagues (2011) have extended this research using a categorization paradigm. One group of 3.5-month-old infants was habituated to bimodal videos of both their mother and father posing a happy or sad facial expression and speaking in an emotionally congruent tone; a second group of 3.5-month-old infants was habituated to bimodal videos of an unfamiliar female and male posing a happy or sad facial expression and speaking in an emotionally congruent tone. During test infants were shown either: a) bimodal videos of their mother acting out the familiarized expression, b) an unfamiliar woman acting out the familiarized expression, c) their mother acting out a novel expression (sad or happy), or c) an unfamiliar female acting out a novel expression (sad or happy). Results revealed that an increased amount of looking time during test was found only for infants first familiarized to their mothers and fathers. Specifically, these infants demonstrated longer looking towards mothers posing novel expressions, unfamiliar females posing novel expressions, and mothers posing familiarized expressions during test. Findings suggested that person familiarity was important in facilitating early discrimination abilities.

Although research is beginning to examine the effects of familiarity on infants' ability to discriminate and recognize facial expressions of emotion (Kahana-Kalman & Walker-Andrews, 2001; Walker-Andrews et al., 2011), it is currently unknown whether infants are able to categorize facial expressions when expressed by multiple caregivers. Specifically, it is unknown whether infants are able to generalize across multiple static photographs of their female

caregivers (e.g., mothers, aunts, grandmothers, cousins) in order to categorize a facial expression of emotion, and discriminate between the categorized expression and novel expression during test. The current study will investigate 6-, 8 and 9-month-old infants' ability to categorize a facial expression of emotion and generalize across identity to recognize a novel facial expression of emotion when facial expressions are posed by unfamiliar women. Further, the current study will examine 6-month-old infants' ability to categorize a facial expression of emotion and generalize across identity to recognize a novel facial expression of emotion when facial expressions are posed by familiar women (i.e., female caregivers).

This study will extend previous findings by investigating the ability to categorize fearful facial expressions of emotion and discriminate between fear and a novel happy expression in 6-, 8- and 9-month-old infants, as this ability has never been tested in infants younger than younger than 7 months. Further, the current study will extend previous literature by investigating these abilities in 6- month-old infants when familiar models (i.e., caregivers) are used as compared to unfamiliar models. This will elucidate whether these abilities emerge earlier in infancy when infants are familiar with the identity of those expressing the emotions.

The Current Study

Studies 1a and 1b: 6-month-olds' Categorization of Facial Expressions on Unfamiliar Faces

Studies 1a and 1b examined whether 6-month-old infants were able to generalize across three unfamiliar female models' identities in order to categorize a familiar facial expression

(happy or fear), and discriminate between that familiarized expression and a novel expression. In both studies, a between subjects design was used; approximately half of the infants in each of the studies were familiarized to happy facial expressions and the other half were familiarized to fearful facial expressions. Study 1a examined whether 6-month-old infants were able to categorize facial expressions that vary in intensity. Study 1b examined whether 6-month-old infants are able to categorize facial expressions that have the same intensity.

It was hypothesized that if 6-month-old infants were able to generalize across the three different models' identities to categorize the familiar expression, they would be able to discriminate between the familiarized expression and a novel expression expressed by a new model. That discrimination would be expressed by significantly longer looking at the novel expression than at the familiarized expression during the test phase. This would demonstrate that despite changes in model identity, the novel expression displayed during the test phase is perceived by the infant as belonging to a different category of facial expression than the familiarized expression.

It was predicted that 6-month-olds would be able to categorize happy expressions across changes in identity and discriminate happy expressions from fearful expressions, based on findings in Bornstein and Arterberry (2003) suggesting successful categorization of happy expressions by 5 months of age. However, no research has previously examined the ability to categorize fearful expressions across changes in identity and discriminate fearful expressions from happy expressions in infants younger than 7 months of age (Nelson & Dolgin, 1985);

therefore, it was uncertain whether 6-month-old infants would be able to categorize fearful expressions.

Study 1c: 6-month-olds' Categorization of Facial Expressions on Caregiver Faces

Study 1c examined whether 6-month-olds were able to generalize across three female caregivers' identities (e.g., mother, aunt, grandmother) in order to categorize a familiar facial expression (happy or fear), and discriminate between that familiarized expression and a novel expression. A between subjects design was used; approximately half of the infants in the study were familiarized to happy facial expressions and the other half were familiarized to fearful facial expressions.

It was hypothesized that if 6-month-old infants were able to generalize across the three different caregivers' identities in order to categorize the familiar expression, they would be able to discriminate between the familiarized expression and a novel expression expressed by a new caregiver.

As discussed earlier, previous literature has demonstrated that 3.5-month-olds are quite sensitive to expressions of emotion posed by their primary caregivers (e.g., mother) and secondary caregivers (e.g., father), as compared to those of an unfamiliar model (Montague & Walker-Andrews, 2002). Further, it has been suggested that caregivers provide examples of posed expressions to which young infants are most frequently exposed (Kahana-Kalman & Walker-Andrews, 2001), and that perceptual expertise with a specific category may facilitate categorization abilities by 3 months of age (Quinn & Tanaka, 2007). Therefore, it was expected

that 6-month-old infants would be able to demonstrate categorization of both happy and fearful facial expressions posed by their caregivers.

Study 2: 8- and 9-month-olds' Categorization of Facial Expressions on Unfamiliar Faces

Study 2 examined whether 8- and 9-month-old infants are able to generalize across three unfamiliar female models' identities in order to categorize a familiar facial expression (happy or fear), and discriminate between that familiarized expression and a novel expression. A between subjects design was used; approximately half of the infants in the study were familiarized to happy facial expressions and the other half were familiarized to fearful facial expressions. As in Study 1, it was hypothesized that if 8- and 9-month-old infants are able to categorize the familiar expression across the identities, they would look longer at the novel expression than at the familiarized expression during the test phase, demonstrating perception of the novel expression as belonging to a different category than the familiarized expression.

Based on findings from previous literature (Nelson & Dolgin, 1985; Nelson, Morse, & Leavitt, 1979; Luddeman, 1991), it was expected that 8- and 9-month-olds would demonstrate categorization of happy facial expressions across changes in identity. However, it was uncertain whether 8- and 9-month-olds would demonstrate categorization of fearful facial expressions across changes in identity because previous research has shown that 7-month-olds are not able to categorize fearful facial expressions (Nelson & Dolgin, 1985; Nelson & Ludemann, 1988).

Method

Study 1a

Participants. Twenty-two infants (11 males, 11 females) participated in Study 1a at 6 months of age (*M* age = 6.47 months, *SD*= .47). All infants were born within (+/-) 4 weeks of their expected due date. None of the infants were diagnosed with visual impairment or clinical disorders (e.g., pervasive developmental disorders, mental retardation, fetal alcohol spectrum disorders, etc.). Twelve additional infants were tested, but their data were eliminated from analysis due to: a) infant fussiness (*n* = 6), b) experimenter error (*n* = 2), c) the infant was not born within (+/-) 4 weeks of expected due date (*n* = 1), or d) the infant did not habituate (*n* = 3). The sample was comprised of Caucasian (77%), Black (5%), and Mixed (18%) participants.

Participants were recruited through the Infant and Child Studies Database at Ryerson University, which contains contact information for parents from across the Greater Toronto Area (GTA) who expressed an interest in participating in research. Recruitment sites consist of a variety of different locations including parent conventions, libraries, community centres, early learning centres, daycares, fitness facilities, and playgroups.

Questionnaires. Parents completed two questionnaires. The Demographic Questionnaire obtained general history and background information about the infant. Specifically, information was collected regarding the infant's birthdate, race/ethnicity, whether the infant was born within (+/-) 4 weeks of his/her expected due date, whether the infant was diagnosed with any clinical disorders (e.g., fetal alcohol syndrome) and/or visual impairment (see Appendix C). The Infant-Caregiver Interaction Scale obtained information regarding the quantity and quality of

interactions between infants and their primary caregiver, three other caregivers, and unfamiliar individuals. It also obtained information regarding infants' exposure to public places (see Appendix D). Information collected pertaining to the infant's primary caregiver and three other caregivers included: a) caregivers' relation to the infant, b) caregivers' ethnicity/race, c) number of days per week infants interacted with caregivers (i.e., less than 1-2 days, 1-2 days, 3-4 days or 5-7 days), d) the amount of time on average infants spent interacting with caregivers during a typical interaction (i.e., less than 10 minutes, approximately half an hour, approximately one hour, or greater than one hour), and e) the types of interactions infants experienced with caregivers (i.e., non-direct, direct brief interaction, direct interaction involving play, direct interaction involving feeding, changing and other necessary caregiver activities not involving play, and direct interaction involving feeding, changing and other necessary caregiver activities involving play).

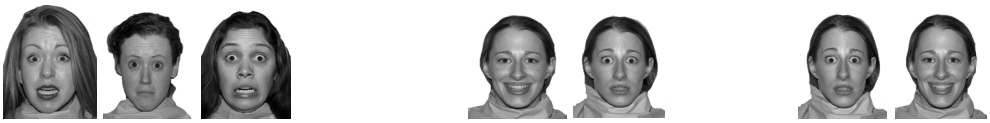
Information collected pertaining to the infant's interactions with unfamiliar individuals and exposure to public places included: a) the number of days per week infants visited public places (i.e., less than 1-2 days, 1-2 days, 3-4 days, 5-7 days), b) the number of days per week infants interacted with unfamiliar people (i.e., less than 1-2 days, 1-2 days, 3-4 days, 5-7 days), c) the amount of time infants spent interacting with unfamiliar individuals during a typical interaction (i.e., less than 10 minutes, approximately half an hour, approximately one hour, or greater than one hour), and d) the types of interactions infants experienced with unfamiliar individuals (i.e., non-direct, direct brief interaction, direct interaction involving play, direct interaction involving feeding, changing and other necessary caregiver activities not involving

play, and direct interaction involving feeding, changing and other necessary caregiver activities involving play).

Stimuli. Colour photographs of four unfamiliar models displaying the facial expressions happy and fear from the MacBrain Face Stimulus Set (Tottenham et al., 2009) were used as stimuli in this study (Figure 1). Two intensities of each emotion (open-mouthed and closed-mouthed) were used to control for possible discrimination biases based on isolated features inherent to a specific expression (e.g., a toothy smile). Two versions of the experiment were created, one with Caucasian models and the other with Asian models. Participants saw the version of the experiment with the stimuli that most closely matched their own racial/ethnic background in order to control for potential differences in processing own- versus other-race faces (Elfenbein & Ambady, 2002). Faces from the MacBrain Face Stimulus Set have been validated. The mean proportion correct score for the happy open-mouthed expression was .98 (*SD*= .02) and for the happy closed-mouthed expression was .92 (*SD*= .07). The mean proportion correct score for the fear open-mouthed expression was .73 (*SD*= .12) and for the fear closed-mouthed expression was .47 (*SD*= .21) (Tottenham et al., 2009). Overall, accurate recognition of happy was much higher than recognition of fear, which suggests higher validity for the happy faces. Further, accurate recognition of open-mouthed happy and fearful expressions was greater than recognition of closed-mouthed versions of these expressions. However, the overall validity attained for the full set of expressions was considered to be within the "substantial" range (Tottenham et al., 2009).

Figure 1. Habituation and Test Stimuli for Studies 1a and 2 (Two-intensity, Unfamiliar Caucasian, Fear Condition)

3 Habituation Stimuli Test Trial 1 Test Trial 2



Procedure. Parents and their infants were recruited as per the methodologies of the Infant and Child Studies Laboratories as described above. Initial contact for all studies occurred via telephone or email. The experimenter provided an overview and invited the parent to participate with their infant. Parents who were interested in participating and whose infants were eligible for the study were invited to schedule a time to come to Ryerson. All appointment times were scheduled when infants were most active and alert, as reported by the primary caregiver. When they arrived for their appointment, participants were guided to the Brain and Early Experiences (BEE) laboratory and the experimenter provided the parent with a consent form (see Appendix A). The experimenter carefully went through each component of the consent form with the parent and asked whether they had any questions after describing each component. Following administration of the consent form, the parent was provided with the Demographic Questionnaire and Infant-Caregiver Interaction Questionnaire. Again, the experimenter thoroughly explained each questionnaire, and answered any questions.

Following completion of the questionnaires, participants were guided to a testing room where the infants participated in an infant-controlled habituation paradigm (Horrowitz, 1974). The infant was seated on the parent's lap, facing a computer screen. Infants were seated 36 centimetres away from the screen. Parents were instructed to wear a sleep mask during stimulus presentation, in order to avoid the possibility of parent behaviour influencing infant looking behaviour. A video camera was situated directly above the computer screen, positioned downward at the infant's face, in order to capture infant looking behavior. The video camera was a Sony Handicam model number DCR-HC52. The video signal was projected onto a second

computer screen in an adjacent room viewed by the experimenter. The experimenter coded infant looking behavior online during the course of the experiment.

Habituation Procedure. The infant-controlled habituation procedure was programmed and run using Habit X software version 1.0 (Cohen, Atkinson, & Chaput, 2004). Three different models were used as habituation stimuli and one model was used as the test stimulus; which model served as the test stimulus was counterbalanced across infants. During habituation trials, three different female models posing the same facial expression (happy or fear) appeared on the screen one at a time in random order. Between habituation trials, a bouncing-ball attention-getter appeared in the center of the screen to attract the infant's attention to the screen. Acquired looking time commenced when infants looked at the stimulus for a minimum of 1-second. Each trial ended when infants looked away from the screen for a minimum of 2-seconds. The habituation criterion was established as the mean length of the first three trials. Habituation trials continued until the mean length of looking time on three consecutive trials was less than 50% of the habituation criterion, or until the maximum number of habituation trials (30 trials) was reached.

After the habituation criterion was met, two test trials commenced. The test trials consisted of a novel model expressing the habituated facial expression on one side of the screen and a novel facial expression on the other side of the screen. The left-right position of the habituated and novel facial expressions was reversed between the two test trials. Each test trial lasted for 10 seconds.

The experimenter and a research assistant blind to condition and left-right position of the novel stimulus coded infant looking time during test trials offline. Test trials were coded frame-by-frame at 30 frames/second through the use of Adobe Premiere Pro software version 5.5. Inter-observer reliability was calculated using Pearson correlation coefficients. Inter-observer reliability between coders was r= .89 (SD= .04).

Study 1b

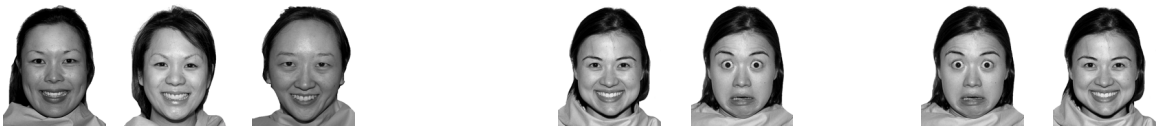
Participants. Fifteen infants (10 males, 5 females) participated in Study 1b at 6-months of age (M age = 6.66 months, SD= .37). All infants were born within (+/-) 4 weeks of their expected due date. None of the infants were diagnosed with visual impairment or clinical disorders (e.g., pervasive developmental disorders, mental retardation, fetal alcohol spectrum disorders, etc.). One additional infant was tested; however, the data were eliminated from analysis because the infant did not habituate. The sample was comprised of Caucasian (53.3%), Asian (13.3%), and Mixed (33.4%) participants. Participants were recruited as per Study 1a.

Stimuli. Stimuli were identical to those used in Study 1a, except that only one- intensity of each emotion (open-mouthed) was used in this study (Tottenham et al., 2009; see Figure 2). It was expected that using only one- intensity would facilitate categorization of the expressions across identity. Findings have suggested that adults judge the most extreme prototypes of facial expressions as the best representations of emotions (Horstmann, 2002), and adult mean proportion correct accuracy ratings were higher for open- than closed-mouthed versions of each expression (happy and fear) in the MacBrain Face Stimulus Set (Tottenham et al., 2009).

Procedure. The general procedure and habituation procedure were identical to Study 1a.

Figure 2. Habituation and Test Stimuli for Study 1b (One-intensity, Unfamiliar Asian, Happy Condition)

3 Habituation Stimuli Test Trial 1 Test Trial 2



Study 1c

Participants. Thirteen infants (6 males, 7 females) participated in Study 1c at 6 months of age (*M* age= 6.59, *SD*= .5). All infants were born within (+/-) 4 weeks of their expected due date. None of the infants were diagnosed with visual impairment or clinical disorders (e.g., pervasive developmental disorders, mental retardation, fetal alcohol spectrum disorders, etc.). Four additional infants were tested; however, their data were eliminated from analysis due to: a) infant fussiness (*n* = 2), or b) the infant was not born within (+/-) 4 weeks of expected due date (*n* = 2). The sample was comprised of Caucasian (61.5%), Asian (7.7%), and Mixed (30.8%) participants. All participants were recruited as per Studies 1a and 1b.

Stimuli. Photographs of four different female caregivers (three habituation, one test) displaying happy and fear facial expressions were collected. One-intensity (open-mouthed) versions of each expression were included as stimuli (Figure 3). All caregiver photographs captured caregivers' faces from the shoulders up against a plain white background. Caregivers included as stimuli in the study all had previous experience interacting with the infant. Facial expressions were identical to those used in Studies 1a and 1b (happy and fear). The experimental design was identical to Studies 1a and 1b, with the exception of using caregivers as models rather than unfamiliar individuals.

Figure 3. Habituation and Test Stimuli for Study 1c (One- intensity, Familiar Caucasian, Happy Condition)

3 Habituation Stimuli Test Trial 1 Test Trial 2

Procedure. In Study 1c, the procedure was followed as in Studies 1a and 1b with minor exceptions. Parents who were interested in participating and whose infants were eligible for the study were invited to schedule two appointments. The first appointment was scheduled at the parent's home in order to obtain photographs of multiple female caregivers expressing facial expressions. Before the visit participants were instructed to wear minimal or no make-up and to remove any jewelry for the photo shoot. At the parent's home, a member of the research team provided study information and a photo release form to all caregivers agreeing to be photographed in the study (see Appendix F). Any questions pertaining to the study were answered. Caregivers were instructed to pose open-mouthed happy and fearful facial expressions, and were provided with an example of a woman posing both expressions from the MacBrain Face Stimulus Set (Tottenham et al., 2009). Caregivers were instructed to pay close attention to changes in eye, brow and mouth areas of the face specific to each expression. Further, caregivers were provided with a mirror and instructed to practice, and imagine scenarios by which would evoke happy and fearful emotions (e.g., fear: you witness a car accident). This method has been used in previous research (Haviland & Lelwica, 1987) to evoke specific emotions in participants. Following this practice session, a white cloth was draped across caregivers' shoulders and neck in order to cover clothing, and caregivers were seated or stood 139.7 centimetres away from the camera (measured from caregivers' chin to the camera lens). A second research team member held a plain white board behind caregivers' head and shoulders, in order to standardize the background in all photographs. Multiple photographs of each expression were captured to ensure the best representation of each expression for use in the study.

Photographs were captured using a Sony NEX-5K digital camera. After each caregiver was photographed, a second appointment was scheduled at Ryerson University.

Caregiver photographs were edited and standardized in the laboratory using Adobe Photoshop software version 5.1. Specifically, photographs were chosen based on subjective ratings by the experimenter as the "best" representations of each expression posed by each caregiver. These photographs were cropped to include only caregivers' faces and plain white background. Further, cropped proportion measurements (in centimetres) and lighting were standardized across photographs. Lastly, photographs were programmed into the habituation procedure.

All caregiver photographs were rated by 10 naïve observers (e.g., research assistants and graduate students). Observers labeled each expression in a forced choice task in which they had to choose one of six facial expressions of emotion (i.e., happy, angry, surprised, sad, fearful, or neutral), and rated the intensity of each expression using a Likert scale ranging from 1-low intensity to 5-high intensity. Observers' mean proportion correct score for fear was .32 (*SD*= .16). This was significantly different than a chance value of .166, $t(10)= 3.22$, $p= .009$. Observers' mean proportion correct score for happy was .99 (*SD*= .009). This was significantly different than a chance value of .166, $t(10)=304.8$, $p=.000$. On average, observers' intensity rating for the fearful facial expressions was 3.5, and 70% of observers rated fearful facial expressions as having an intensity of 3 and above. Further, on average observers' intensity rating for the happy facial expressions was 3.42, and 88.5% of observers rated happy facial expressions as having an intensity of 3 and above.

It should be noted that not all infants who participated in the study had three female caregivers in addition to the infant's mother. Due to time restraints, participants that had two female caregivers in addition to the infant's mother were still invited to participate in the study. For these participants, a caregiver photograph matched for race/ethnicity from another participant's stimulus set was substituted in the habituation paradigm as one of the habituation stimuli. Infants never saw the substituted caregiver during test trials.

Habituation Procedure. The habituation procedure was identical to Studies 1a and 1b.

Study 2

Participants. Sixteen infants (7 males, 9 females) participated in Study 2 at 8 and 9 months of age (M= 9.02, SD= .78). All infants were born within (+/-) 4 weeks of their expected due date. None of the infants were diagnosed with visual impairment or clinical disorders (e.g., pervasive developmental disorders, mental retardation, fetal alcohol spectrum disorders, etc.). Five additional infants were tested; however, their data were eliminated from the analysis due to: a) infant fussiness (n=3), b) experimenter error (n=1), or c) infant was not born within (+/-) 4 weeks from expected due date (n=1). The sample was comprised of Caucasian (75%), Asian (6.25%), Hispanic (6.25%) and Mixed (12.5%) participants. All participants were recruited as per Studies 1a, 1b, and 1c.

Stimuli and Procedure. The stimuli, procedure and habituation procedure were identical to Study 1a.

Results

Infant Looking Time Coding

Infant looking time during the two test trials was coded for left, right, and off stimulus looks frame-by-frame using Adobe Premiere version 5.5 software. The total number of frames infants looked left or right corresponded to the number of frames infants looked towards the novel and familiar facial expressions within each trial. The number of frames infants looked towards the novel facial expression within each trial was summed across both test trials (Total Looking to Novel). Then, the number of frames infants looked towards both the novel and familiar facial expressions were summed across both test trials (Total Looking to Both Familiar and Novel). Proportion looking time towards the novel facial expression was calculated by dividing Total Looking to Novel by Total Looking to Both Familiar and Novel. One sample *t*-tests were computed to determine whether the proportion looking time to the novel facial expression was significantly different from a chance value of .5 (i.e., if infants showed a "novelty preference").

Study 1a: Proportion Looking Time Results

In Study 1a (6 months, unfamiliar, two-intensity), normality was assessed visually through a histogram and P-P plot. Proportion looking time across both happy and fear conditions appeared to be slightly positively skewed. The distribution was confirmed to be normally distributed by the Shapiro-Wilk test, $w(22) = .947$, $p = .277$. Proportion looking time to the novel stimulus ranged from .38 to .89. On average, infants demonstrated a significant novelty

preference (*M*= .56, *SD*= .13), *t*(21)= 2.25, *p*= .035 (Table 1). This indicates that infants were able to generalize across the three unfamiliar identities to categorize the facial expressions.

A greater number of infants in Study 1a were habituated to happy facial expressions (*n* = 16) than fearful facial expressions (*n* = 6) because data from five infants habituated to fear were excluded from the analysis due to fussiness (*n* = 3) or experimenter error (*n* = 2). As mentioned earlier, order effects in infants' ability to categorize happy and fearful facial expressions have been found in previous literature (Nelson & Dolgin, 1985; Nelson & Ludemann, 1988). To determine whether, a) the number of infants habituated to happy as compared to fearful facial expressions affected the novelty preference found across both conditions, and b) differences in novelty preference would be found depending on whether infants were habituated to happy versus fearful facial expressions, infants' proportion looking time to the novel facial expression (happy or fear) was examined in each condition separately.

In the happy condition, proportion looking time appeared to be normally distributed, revealed by a histogram and P-P plot. Normality of the distribution was confirmed by the Shapiro-Wilk test, *w*(16)= .95, *p*= .54. Proportion looking time ranged from .38 to .89. On average, infants demonstrated a significant novelty preference (*M*= .58, *SD*= .14), *t*(15)= 2.2, *p*= .048 (Table 1). This indicated that infants were successfully able to generalize across three unfamiliar female identities to categorize the happy facial expressions. In the fear condition, proportion looking time appeared to be positively skewed, revealed by a histogram and P-P plot. The Shapiro-Wilk test indicated that the distribution was normal, *w*(6)= .92, *p*= .511. Proportion looking time ranged from .41 to .70. On average, infants demonstrated a novelty preference (*M*=

.53, *SD*= .11) (Table 1). However, this was not significantly greater than a chance value of .5, $t(5) = .68$, $p = .529$. Therefore, evidence was not found that infants were able to generalize across three unfamiliar female identities to categorize fearful facial expressions. To examine whether the novelty preferences for the happy and fearful conditions differed significantly, an independent samples *t*-test was conducted. Although infants demonstrated a larger novelty preference in the happy condition (*M*= .58, *SD*= .14) than the fear condition (*M*= .53, *SD*= .11), this difference was not significant, $t(20) = -.694$, $p = .480$. Despite no significant difference in novelty preference between the happy and fear conditions, the novelty preference found across both happy and fear conditions may be driven by the greater number of infants habituated to happy facial expressions versus fearful facial expressions.

Table 1. Study 1a: Proportion Looking Time Descriptive Statistics

Proportion Looking Time	N	Range	Minimum	Maximum	Mean	SD
Happy and Fear Conditions	22	.51	.38	.89	.56	.13
Happy Condition	16	.51	.38	.89	.58	.14
Fear Condition	6	.29	.41	.70	.53	.11

Study 1b: Proportion Looking Time Results

In Study 1b (6 months, unfamiliar, one-intensity), proportion looking time across both happy and fear conditions appeared to be slightly negatively skewed, revealed by a histogram and P-P plot. Normality of the distribution was confirmed by the Shapiro-Wilk test, $w(15)= .9$, $p= .083$. Proportion looking time ranged from .29 to .76. On average, infants demonstrated a novelty preference ($M= .56$, $SD= .14$) (Table 2). However, this was not significantly greater than a chance level of .5, $t(14)= 1.57$, $p= .138$. Therefore, evidence was not provided that infants were able to generalize across three unfamiliar female identities to categorize fearful facial expressions. It is surprising that there was not a significant novelty preference in this study, whereas there was a significant novelty preference in Study 1a. However, it seems that the significant novelty preference in Study 1a was driven by infants habituated to happy faces. Therefore, we examined novelty preferences separately for the happy and fear conditions.

The distribution of proportion looking time in the happy condition appeared to be approximately normal, revealed by a histogram and P-P plot. Normality of the distribution was confirmed by the Shapiro-Wilk test, $w(8)= .94$, $p= .58$. Proportion looking time ranged from .5 to .76. On average, infants demonstrated a significant novelty preference ($M= .63$, $SD= .08$), $t(7)= 4.8$, $p= .002$ (Table 2). This indicated that infants were able to generalize across the three unfamiliar female identities and categorize the happy facial expressions. Proportion looking time in the fear condition appeared to be slightly positively skewed, revealed by a histogram and P-P plot. Normality of the distribution was indicated by the Shapiro-Wilk test, $w(7)= .87$, $p= .182$. Proportion looking time ranged from .29 to .69. On average, infants did not demonstrate a

novelty preference (*M*= .48, *SD*= .17) (Table 2). This was not significantly different from a chance value of .5, *t*(6)= -.36, *p*= .727. Therefore, evidence was not found that infants were able to generalize across three unfamiliar female identities to categorize fearful facial expressions. To investigate whether infants' proportion looking time in the happy and fear conditions differed significantly, an independent samples *t*-test was conducted. Infants demonstrated significantly greater proportion looking time in the happy condition (*M*=.63, *SD*= .076) than in the fear condition (*M*= .48, *SD*= .17), *t*(13)= -.2.36, *p*= .035.

Table 2. Study 1b: Proportion Looking Time Descriptive Statistics

Proportion Looking Time	N	Range	Minimum	Maximum	Mean	SD
Happy and Fear Conditions	15	.47	.29	.76	.56	.14
Happy Condition	8	.26	.5	.76	.63	.08
Fear Condition	7	.4	.29	.69	.48	.17

Study 1c: Proportion Looking Time Results

In Study 1c (6 months, familiar, one-intensity), proportion looking time across both happy and fearful conditions appeared to be normally distributed, revealed by a histogram and P-P plot. Normality of the distribution was confirmed by the Shapiro-Wilk test, $w(13)= .94$, $p= .464$. Proportion looking time ranged from .41 to .69. One score was flagged as an outlier (.85, *z*-score= 2.31), and was corrected by replacing it with the mean plus two standard deviations (Field, 2009). On average, infants demonstrated a significant novelty preference ($M= .56$, $SD= .09$), $t(12)= 2.46$, $p=.03$ (Table 3). To determine whether there were differences in novelty preference depending on whether infants were habituated to happy or fearful faces (as in Studies 1a and 1b), novelty preferences were calculated separately for the happy and fear conditions.

In the happy condition, proportion looking time appeared to be negatively skewed. The distribution was normal, indicated by the Shapiro-Wilk test $w(8)= .91$, $p=.35$. Proportion looking time scores ranged from .42 to .69. On average, infants demonstrated a significant novelty preference ($M= .59$, $SD= .08$), $t(6) = 2.48$, $p= .048$ (Table 3). In the fear condition, proportion looking time scores appeared to be approximately normally distributed as indicated by a histogram and P-P plot. Normality was confirmed by the Shapiro-Wilk test, $w(5)= .93$, $p=.6$. Proportion looking time scores ranged from .41 to .63. On average, infants' proportion looking time was approximately at a chance level of .5 ($M= .51$, $SD= .08$) (Table 3). This was not significantly different from chance, $t(4)= .4$, $p= .71$. To determine whether infants' proportion looking time in the happy and fear conditions differed significantly, an independent samples *t*-test was conducted. Although infants demonstrated greater proportion looking time in the happy condition ($M=.58$, $SD= .08$) than in the fear condition ($M= .51$, $SD= .01$), this difference was not

significant, $t(11) = -1.58$, $p = .143$. Therefore, the novelty preference found across both happy and fear conditions may be driven by the infants habituated to happy facial expressions versus fearful facial expressions.

Table 3. Study 1c: Proportion Looking Time Descriptive Statistics

Proportion Looking Time	N	Range	Minimum	Maximum	Mean	SD
Happy and Fear Conditions	13	.28	.41	.69	.56	.09
Happy Condition	7	.27	.42	.69	.58	.09
Fear Condition	5	.22	.63	.41	.51	.08

Study 2: Proportion Looking Time Results

In Study 2 (8 and 9 months, unfamiliar, two-intensity), proportion looking time across both happy and fear conditions appeared to be normally distributed, revealed by a histogram and P-P plot. Normality of the distribution was confirmed by the Shapiro-Wilk test, $w(16)= .96$, $p= .575$. One score was flagged as an outlier (.72, z-score= 2.6), and was corrected by replacing it with the mean plus two standard deviations (Field, 2009). Proportion looking time ranged from .41 to .64. On average, infants demonstrated a significant novelty preference ($M= .54$, $SD= .06$), $t(16)= 3.02$, $p=. 009$ (Table 4). To determine whether differences in novelty preference existed depending on whether infants were habituated to happy versus fearful facial expressions, infants' proportion looking time was examined for happy and fear conditions separately.

Proportion looking time scores in the happy condition appeared to be approximately normally distributed, revealed by a histogram and P-P plot. Normality of the distribution was confirmed by the Shapiro-Wilk test, $w(8)= .96$, $p= .83$. Proportion looking scores ranged from .5 to .64. On average, infants demonstrated a significant novelty preference ($M= .57$, $SD= .05$), $t(7)= 4.4$, $p= .003$ (Table 4). Proportion looking time in the fear condition appeared slightly positively skewed revealed by a histogram and P-P plot. Normality of the distribution was indicated by the Shapiro-Wilk test, $w(8)= .91$, $p= .354$. Proportion looking scores ranged from .41 to .58. On average, infants demonstrated a novelty preference ($M= .52$, $SD= .06$) (Table 4). However, this was not significantly greater than a chance level of .5, $t(7)= .76$, $p= .47$. To examine whether infants' proportion looking time in the happy and fear conditions significantly differed, an independent samples t-test was conducted. On average, infants demonstrated greater

proportion looking time in the happy condition (*M*= .57, *SD*= .05) as compared to the fear condition (*M*= .52, *SD*= .06). This difference was significant, $t(14) = -2.23$, $p = .042$.

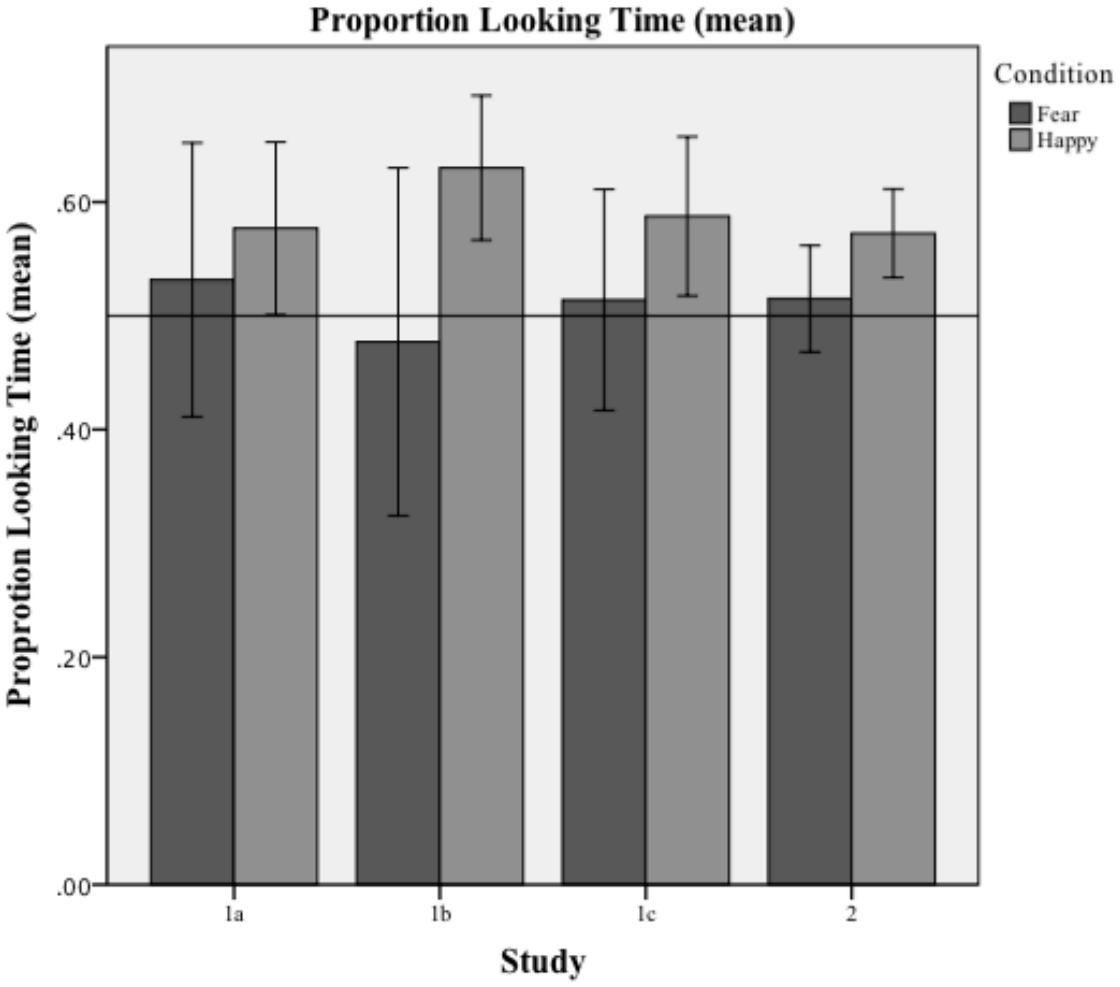
Table 4. Study 2: Proportion Looking Time Descriptive Statistics

Proportion Looking Time	N	Range	Minimum	Maximum	Mean	SD
Happy and Fear Conditions	16	.23	.41	.64	.54	.06
Happy Condition	8	.14	.5	.64	.57	.05
Fear Condition	8	.17	.41	.58	.52	.06

Summary of Proportion Looking Time Results

Proportion looking time results indicated a significant novelty preference in Studies 1a, 1c, and 2 across both happy and fear conditions. (Figure 4). However, these novelty preferences appear to be driven by infants habituated to happy facial expressions (infants in the happy condition), as a significant novelty preference was only found for infants habituated to happy, but not fearful facial expressions in each of the three studies. It is possible that this overall pattern of results may be due to differences between the happy and fear conditions in the amount of looking during the habituation phase. Therefore, the amount of total looking time toward the facial expressions during the habituation phase was compared for both happy and fear conditions in Studies 1a, 1b, 1c and 2.

Figure 4. Infant Proportion Looking Time in Studies 1a, 1b, 1c and 2 (Happy versus Fear Conditions)



* Error bars represent a 95% confidence interval

Study 1a: Habituation Looking Time Results

One of the total looking time scores was flagged as an outlier (394.8 seconds, *z*-score= 3.8); therefore, this score was corrected by substituting it with the mean plus two standard deviations. In the happy condition, total looking time during the habituation phase appeared to be positively skewed, revealed by a histogram and P-P plot. Non-normality was revealed by the Shapiro-Wilk test, $w(15)= .83$, $p= .01$. Total looking time ranged from 38.7 to 157.4 seconds. On average, infants looked at the happy facial expressions during habituation for a total of 79.22 seconds (*SD*= 38.9). The total number of trials infants viewed during habituation appeared to be positively skewed, revealed by a histogram and P-P plot. Non-normality of the distribution was indicated by the Shapiro-Wilk test, $w(15)= .806$, $p=.004$. Infants saw 8.4 habituation trials (*SD*= 3.6) before reaching the habituation threshold (Table 5). In the fear condition, total looking time during the habituation phase appeared to be slightly positively skewed, revealed by a histogram and P-P plot. The distribution was normal, indicated by the Shapiro-Wilk test, $w(6)= .9$, $p= .39$. Total looking time ranged from 39.4 to 148.7 seconds. On average, infants looked at the fearful facial expressions during habituation for a total of 78.5 seconds (*SD*= 40.44). The total number of trials infants viewed during habituation appeared to be positively skewed, revealed by a histogram and P-P plot. Normality of the distribution was indicated by the Shapiro-Wilk test, $w(6)= .833$, $p=.113$. Infants saw 9.67 habituation trials (*SD*= 5.5) before reaching the habituation threshold (Table 5). Non-parametric Mann-Whitney tests were generated due to non-normality of the habituation looking time distribution and the number of habituation trials distribution (Field, 2009). The Mann-Whitney test revealed that there was no significant difference in total amount of looking during habituation between the happy and fear conditions, $U= 43.5$, $z= -.117$, $p=. 91$.

Additionally, the Mann-Whitney test indicated that there was no significant difference in the number of habituation trials viewed between the happy and fear conditions, $U=40$, $z=-.395$, $p=.693$.

Table 5. Study 1a: Habituation Looking Time Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	SD
Happy Condition: Total Looking Time (seconds)	15	118.7	38.7	157.4	79.22	38.9
Happy Condition: Number of Habituation Trials	15	11	5	16	8.4	3.6
Fear Condition: Total Looking Time (seconds)	6	109.3	39.4	148.7	78.52	40.44
Fear Condition: Number of Habituation Trials	6	15	5	20	9.7	5.5

* Data are missing from one participant in the Happy condition

Study 1b: Habituation Looking Time Results

In the happy condition, infants' total looking time during the habituation phase was normality distributed, revealed by a histogram and P-P plot. Normality was confirmed by the Shapiro-Wilk test, $w(8)= .85$, $p= .094$. Total looking time ranged from 55.5 seconds to 251.2 seconds. On average, infants looked at the happy facial expressions for a total of 138.37 seconds (*SD*= 83.09). The total number of trials infants viewed during habituation appeared to be positively skewed, revealed by a histogram and P-P plot. Normality of the distribution was indicated by the Shapiro-Wilk test, $w(8)= .84$, $p=.075$. Infants saw 14.38 habituation trials (*SD*= 9.27) before reaching the habituation threshold (Table 6). In the fear condition, total looking time during the habituation phase appeared to be normally distributed, revealed by a histogram and P-P plot. Normality was confirmed by the Shapiro-Wilk test, $w(6)= .92$, $p= .509$. Total looking time ranged from 69.9 seconds to 193.5 seconds. On average, infants looked at the fearful facial expressions for a total of 120.88 seconds (*SD*= 48.14). The total number of trials infants viewed during habituation appeared to be positively skewed, revealed by a histogram and P-P plot. Normality of the distribution was indicated by the Shapiro-Wilk test, $w(6)= .90$, $p=.383$. Infants saw 13.33 habituation trials (*SD*= 8.24), before reaching the habituation threshold (Table 6). An independent samples t-test revealed that there was no significant difference in total amount of looking during habituation between the happy and fear conditions, $t(12)= -.46$, $p= .655$. Additionally, an independent samples *t*-test indicated that there was no significant difference in the number of habituation trials viewed between the happy and fear conditions, $t(12)= -.218$, $p= .831$.

Table 6. Study 1b: Habituation Looking Time Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	SD
Happy Condition: Total Looking Time (seconds	8	195.7	55.5	251.2	138.37	83.09
Happy Condition: Number of Habituation Trials	8	23	5	28	14.38	9.27
Fear Condition: Total Looking Time (seconds)	6	123.6	69.9	193.5	120.88	48.14
Fear Condition: Number of Habituation Trials	6	23	5	28	13.33	8.24

* Data are missing from one participant in the Fear condition

Study 1c: Habituation Looking Time Results

In the happy condition, infants' total looking time during the habituation phase appeared to be normality distributed, revealed by a histogram and P-P plot. Normality was confirmed by the Shapiro-Wilk test, $w(8)= .94$, $p= .568$. Total looking time ranged from 55.5 seconds to 251.2 seconds. Total looking time ranged from 33.2 seconds to 186.1 seconds. On average, infants' looked at happy facial expressions for a total of 93.38 seconds ($SD= 52.87$). The total number of trials infants viewed during habituation appeared to be positively skewed, revealed by a histogram and P-P plot. Normality of the distribution was indicated by the Shapiro-Wilk test, $w(8)= .869$, $p=.146$. Infants saw 8.13 habituation trials ($SD= 3.48$) before reaching the habituation threshold. (Table 7). In the fear condition, total looking time during the habituation phase appeared to be slightly positively skewed, revealed by a histogram and P-P plot. Normality was revealed by the Shapiro-Wilk test, $w(5) = .97$, $p= .899$. Total looking time ranged from 66.3 seconds to 243.6 seconds. On average, infants' looked at the fearful facial expressions for a total of 141.7 seconds ($SD= 69.1$). The total number of trials infants viewed during habituation appeared to be positively skewed, revealed by a histogram and P-P plot. Normality of the distribution was indicated by the Shapiro-Wilk test, $w(5)= .836$, $p=.154$. Infants saw 15 habituation trials ($SD= 11.73$), before reaching the habituation threshold. (Table 7). An independent samples *t*-test revealed that there was no significant difference in total amount of looking during habituation between the happy and fearful conditions, $t(11)= 1.31$, $p= .218$. Additionally, an independent t-test indicated that there was no significant difference in the number of habituation trials viewed between the happy and fear conditions, $t(1.28)= 1.28$,

p=.264 (homogeneity of variance was not assumed as revealed by the Levene's test, $F(1, 11)$= 2.52, p= .001).

Table 7. Study 1c: Habituation Looking Time Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	SD
Happy Condition: Total Looking Time (seconds)	8	152.9	33.2	186.10	93.38	52.87
Happy Condition: Number of Habituation Trials	8	10	5	15	8.13	3.48
Fear Condition: Total Looking Time (seconds)	5	177.3	66.3	243.6	141.7	69.1
Fear Condition: Number of Habituation Trials	5	25	5	30	15	11.73

Study 2: Habituation Looking Time Results

In the happy condition, infants' total looking time appeared to be slightly positively skewed, revealed by a histogram and P-P plot. Normality was indicated by the Shapiro-Wilk test, $w(8)= .91$, $p= .36$. Total looking time ranged from 39.8 seconds to 122.3 seconds. On average, infants' looked at the happy facial expressions for a total of 68.98 seconds ($SD= 26.76$). The total number of trials infants viewed during habituation appeared to be slightly positively skewed, revealed by a histogram and P-P plot. Normality of the distribution was indicated by the Shapiro-Wilk test, $w(8)= .911$, $p=.363$. Infants saw 8.5 habituation trials ($SD= 8.21$) before reaching the habituation threshold. (Table 8). In the fear condition, infants' total looking time during the habituation phase appeared to be positively skewed, revealed by a histogram and P-P plot. Normality was indicated by the Shapiro-Wilk test, $w(8)= .91$, $p= .331$. Total looking time ranged from 43.3 seconds to 215.47 seconds. On average, infants looked at the fearful facial expressions for a total of 105.83 seconds ($SD= 55.1$). The total number of trials infants viewed during habituation appeared to be normally distributed, revealed by a histogram and P-P plot. Normality of the distribution was indicated by the Shapiro-Wilk test, $w(8)= .964$, $p=.848$. Infants saw 10.13 habituation trials ($SD= 4.58$) before reaching the habituation threshold (Table 8). An independent samples *t*-test revealed that there was no significant difference in total amount of looking during habituation between the happy and fearful conditions, $t(14)= 1.70$, $p= .111$. Additionally, an independent samples *t*-test indicated there was no significant difference in the number of habituation trials viewed between happy and fearful conditions, $t(14)= .822$, $p= .425$.

Table 8. Study 2: Habituation Looking Time Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	SD
Happy Condition: Total Looking Time (seconds)	8	82.5	39.8	122.3	68.98	26.76
Happy Condition: Number of Habituation Trials	8	9	5	14	8.5	3.21
Fear Condition: Total Looking Time (seconds)	8	172.17	43.3	215.47	105.83	55.1
Fear Condition: Number of Habituation Trials	8	14	4	18	10.13	4.58

Summary of Habituation Looking Time Results

In Studies 1a, 1b, 1c and 2, no significant differences in infants' looking time during the habituation phase was found between happy and fear conditions. Further, no significant differences in the number of habituation trials viewed was found between happy and fear conditions in all four studies. Therefore, differences in looking time during habituation or the number of habituation trials viewed cannot account for the absence of a significant novelty preference found in the fear condition as compared to the happy condition, in all four studies.

Infant-Caregiver Interaction Questionnaire Descriptive Statistics

To quantify the amount of exposure infants had to their primary caregiver and three other caregivers, a hierarchy score ranging from least experience to most experience was assigned to each relevant question (e.g., number of days per week infants' interacted with caregivers: a score of 0 was assigned for responses indicating less than once per week, a score of 1 was assigned for responses indicating 1-2 days, a score of 2 was assigned for responses indicating 3-5 days and a score of 3 was assigned for responses indicating 5-7 days). Two summary scores were calculated, one for the primary caregiver, and one for the three alternative caregivers. For the three alternative caregivers, a mean of the summary score was calculated. For both the primary caregiver summary score and the alternative caregiver summary score, the minimum score that could be attained was 2 and the maximum score that could be attained was 12. To quantify the amount of exposure infants had to unfamiliar individuals and public places, hierarchy scores ranging from least experience to most experience were assigned to each relevant question (e.g., number of days per week infants visited public places: a score of 0 was assigned for responses

indicating less than once per week, a score of 1 was assigned for responses indicating 1-2 days, a score of 2 was assigned for responses indicating 3-5 days and a score of 3 was assigned for responses indicating 5-7 days). These scores were summed to calculate a summary score. The minimum score that could be attained was 2 and the maximum score that could be attained was 15.

In Studies 1a, 1b, 1c and 2, descriptive statistics were computed for primary caregiver summary scores, alternative caregiver summary scores, and unfamiliar individuals/places summary scores (Table 9). In Study 1a (6 months, unfamiliar, two-intensity), primary caregiver scores ranged from 10-12 (M= 11.82, SD= .5). To assess normality of the distribution, a histogram and P-P plot was generated. These plots revealed that the distribution of scores were slightly negatively skewed, and non-normally distributed. The normality of the distribution was also assessed quantitatively by the Shapiro-Wilk test. The Shapiro-Wilk test revealed non-normality, $w(22)= .58$, $p=.001$. On average, infants experienced a great amount of exposure and time interacting with their primary caregiver. Alternative caregiver scores ranged from 7-12 (M=9.35, SD=1.54). These scores appeared to be normally distributed as revealed by a histogram and P-P plot. Normality was confirmed by the Shapiro-Wilk test, $w(22)= .95$, $p= .318$. Not surprisingly, infants had greater exposure to and interaction with their primary caregivers than alternative caregivers. There was also more variability in how much exposure individual infants received to alternative caregivers compared to the primary caregiver. Unfamiliar individuals/places scores ranged from 4-12 (M= 7.71, SD= 1.87). These scores appeared to be positively skewed and not normally distributed as assessed by a histogram and P-P plot. Non-

normality was confirmed by the Shapiro-Wilk test, $w(21)= .9$, $p=.037$. On average, infants were not exposed to unfamiliar individuals and places as frequently as they were to primary and alternative caregivers. Additionally, there was quite a bit of variability in how much time infants spent in unfamiliar places or with unfamiliar people.

In Study 1b (6 months, unfamiliar, one-intensity), primary caregiver scores ranged from 10-12 ($M= 11.8$, $SD= .56$). To assess normality of the distribution, a histogram and P-P plot was generated. These plots revealed that the distribution of scores was negatively skewed. Non-normality was confirmed by the Shapiro-Wilk test $w(15)= .42$, $p=.000$. On average, infants experienced a great amount of exposure and time interacting with their primary caregiver. Alternative caregiver scores ranged from 7-12 ($M=8.93$, $SD=1.14$). These scores appeared to be positively distributed as revealed by a histogram and P-P plot. However, normality was revealed by the Shapiro-Wilk test, $w(15)= .94$, $p= .375$. On average, infants had greater exposure to and interaction with their primary caregivers than alternative caregivers. There was also more variability in how much exposure individual infants received to alternative caregivers compared to the primary caregiver. Unfamiliar individuals/places scores ranged from 4-11 ($M= 8$, $SD= 1.93$). These scores appeared to be negatively skewed as assessed by a histogram and P-P plot. However, normality was confirmed by the Shapiro-Wilk test, $w(15)= .94$, $p=.358$. On average, infants were not exposed to unfamiliar individuals and places as frequently as they were to primary and alternative caregivers. Additionally, there was quite a bit of variability in how much time infants spent in unfamiliar places or with unfamiliar people.

In Study 1c (6 months, familiar, one-intensity), primary caregiver scores ranged from 11-12 (*M*= 11.83, *SD*= .11). Normality of the distribution was examined by a histogram and P-P plot. These plots revealed that the distribution of scores was negatively skewed. Non-normality was confirmed by the Shapiro-Wilk test $w(12)= .465$, $p=.000$. On average, infants experienced a great amount of exposure and time interacting with their primary caregiver. Alternative caregiver scores ranged from 5-11 (*M*=8.69, *SD*=1.59). These scores appeared to be slightly positively distributed as revealed by a histogram and P-P plot. However, normality was confirmed by the Shapiro-Wilk test, $w(12)= .93$, $p= .338$. On average, infants had greater exposure to and interaction with their primary caregivers than alternative caregivers. There was also more variability in how much exposure individual infants received to alternative caregivers compared to the primary caregiver. Unfamiliar individuals/places scores ranged from 5-12 (*M*= 8, *SD*= 2). These scores appeared to be normally distributed as assessed by a histogram and P-P plot. Scores were confirmed to be normally distributed by the Shapiro-Wilk test, $w(12)= .95$, $p=.642$. On average, infants were not exposed to unfamiliar individuals and places as frequently as they were to primary and alternative caregivers. Moreover, there was quite a bit of variability in how much time infants spent in unfamiliar places or with unfamiliar people.

In Study 2 (8 and 9-months, unfamiliar, two-intensity), primary caregiver scores ranged from 11-12 (*M*= 11.93, *SD*= .27). Normality of the distribution was examined by a histogram and P-P plot. These plots revealed that the distribution of scores was negatively skewed. Non-normality was also revealed by the Shapiro-Wilk test $w(15)= .3$, $p=.000$. On average, infants experienced a great amount of exposure and time interacting with their primary caregiver.

Alternative caregiver scores ranged from 5.67-12 (*M*=8.78, *SD*=1.77). These scores appeared to be normally distributed as revealed by a histogram and P-P plot. Normality was further revealed by the Shapiro-Wilk test, $w(14)= .97$, $p= .884$. On average, infants had greater exposure to and interaction with their primary caregivers than alternative caregivers. There was also more variability in how much exposure individual infants received to alternative caregivers compared to the primary caregiver. Unfamiliar individuals/places scores ranged from 5-13 (*M*= 7.85, *SD*= 2.03). These scores appeared to be positively skewed as assessed by a histogram and P-P plot. Normality was confirmed by the Shapiro-Wilk test, $w(14)= .88$, $p=.078$. On average, infants were not exposed to unfamiliar individuals and places as frequently as they were to primary and alternative caregivers. Moreover, there was quite a bit of variability in how much time infants spent in unfamiliar places or with unfamiliar people.

Infant-Caregiver Interaction Questionnaire Correlation Analysis

In Studies 1a, 1b, 1c and 2, Kendall's Tau-B correlation coefficients were calculated to explore potential relationships between the three measures of interaction from the questionnaires and proportion looking times during the habituation task. Kendall's Tau-B correlation coefficients were computed as, a) the data set was small, b) the questionnaire data were ordinal, and c) the data were not normally distributed (Field, 2009). All correlational tests were 2-tailed, and Bonferroni adjusted alpha levels of .0166 per test were used (.05/3) (Field, 2009; Table 10).

It was expected that 6-, 8- and 9-month-old infants habituated to facial expressions expressed by unfamiliar females (Studies 1a, 1b and 2) who experienced greater exposure and interaction with unfamiliar individuals and public places would tend to demonstrate a novelty

preference. In other words, infants who experienced greater exposure and interaction with unfamiliar individuals and public places would be more successful at categorizing facial expressions expressed by unfamiliar faces than infants who experienced lesser exposure and interaction. Additionally, it was predicted that 6-month-old infants habituated to facial expressions expressed by their female caregivers (Study 1c) who experienced greater exposure and interaction with their alternative caregivers would tend to demonstrate greater proportion looking time toward the novel facial expression (happy or fear). In other words, infants who experienced greater exposure and interaction with their alternative caregivers would be more successful at categorizing facial expressions than infants who experienced lesser exposure and interaction. These hypotheses were based on previous literature suggesting that person and context familiarity enhances emotion recognition and categorization ability in infancy (Walker-Andrews et al., 2011; Quinn & Tanaka, 2007).

There were no significant correlations between any of the measures of interaction and proportion looking times for 6-month-old infants (Studies 1a, 1b, and 1c). In Study 2, there were no significant correlations between primary caregiver exposure and proportion looking time or alternative caregiver exposure and proportion looking time. However, there was a significant negative correlation between exposure to unfamiliar individuals/places and proportion looking time ($\tau = -.566$, $p = .013$). Thus, infants who spent a greater amount of time interacting with unfamiliar individuals and who were exposed more frequently to public places (as reported by their primary caregivers) tended to show decreased looking time toward the novel facial expression (happy or fear) during the test trials. This result is surprising as it suggests that infants

with more exposure to unfamiliar places and people tend to be less successful at categorizing the facial expressions than infants with less exposure to unfamiliar places and people.

Table 9. Infant-Caregiver Interaction Questionnaire Descriptive Statistics

	N	Range of Scores	Mean	Std. Deviation
Study 1a				
Primary Caregiver Scores	22	10-13	11.86	.56
Caregiver Scores	22	7-12	9.35	1.54
Unfamiliar scores	22	4-12	7.71	1.87
Study 1b				
Primary Caregiver Scores	15	10-12	11.8	.56
Caregiver Scores	15	7-12	8.93	1.4
Unfamiliar Scores	15	4-11	8	1.93
Study 1c				
Primary Caregiver Scores	13	11-12	11.85	.38
Caregiver Scores	13	5-11	8.56	1.6
Unfamiliar Scores	13	5-12	8	1.91
Study 2				
Primary Caregiver Scores	15	11-12	11.92	.27
Caregiver Scores	15	5.56-12	8.78	1.77
Unfamiliar Scores	15	5-13	7.85	2.03

* Data are missing from one participant in Study 2

Table 10. Kendall's Tau-B Correlations Between the Caregiver-Interaction Questionnaire and Proportion Looking Time

	Primary Caregiver Scores	Caregiver Scores	Unfamiliar Scores
Study 1a Proportion Looking Time	-.113	.18	.255
Study 1b Proportion Looking Time	.095	-.188	-.01
Study 1c Proportion Looking Time	-.122	.309	.209
Study 2 Proportion Looking Time	-.331	-.08	-.566*

*p<0.0166, (2-tailed).

Discussion

The four studies reported here aimed to elucidate whether 6-, 8-, and 9-month-old infants can successfully generalize across identity in order to categorize happy and fearful facial expressions of emotion, and whether person familiarity enhances that ability. Study 1a examined 6-month-old infants' ability to generalize across three unfamiliar female identities in order to categorize happy and fearful facial expressions varying in intensity. Infants who were habituated to happy faces showed a significant novelty preference during test, whereas infants who were habituated to fearful faces did not. This "order effect" (i.e., successful categorization when habituated to happy and tested on fear, but not the reverse) is consistent with previous literature. Bornstein and Arterberry (2003) demonstrated that 5-month-olds successfully categorized happy facial expressions varying in intensity when tested on fear, but did not test the reverse condition. Other studies have found that 7-month-olds successfully categorized happy facial expressions when tested on fear, but did not find the reverse (Ludemann & Nelson, 1988; Nelson & Dolgin, 1985; Nelson, Morse & Leavitt, 1979). The order effect in the current study does not seem to be driven by differences in looking during the habituation phase of the study, because no differences were found in looking towards happy expressions versus fearful expressions during habituation.

Study 1b examined 6-month-olds infants' ability to generalize across three unfamiliar female identities in order to categorize happy and fearful facial expressions that were all of one-intensity. It was theorized based on previous literature (Tottenham et al., 2009; Horstmann, 2002) that it might be easier for infants to categorize facial expressions that did not vary in

intensity (as in Study 1a). Thus, it was expected that infants might show the ability to categorize fearful faces in this study. Infants did show a significant novelty preference when habituated to happy faces and they did not show a significant novelty preference when habituated to fearful faces. Therefore, Study 1b replicated the order effect found in Study 1a. This suggests that, contrary to our prediction, fearful expressions are not easier for infants to categorize when only one intensity of expression is used. In Study 1b, the order effect did not seem to be due to differences in the habituation phase, because habituation times did not differ for infants habituated to happy compared to fear.

Study 1c examined 6-month-old infants' ability to generalize across three caregiver identities in order to categorize happy and fearful facial expressions that were all of one intensity. It was hypothesized based on previous literature that familiarity would enhance 6-month-old infants' ability to recognize emotion (Kahana-Kalman & Walker-Andrews, 2001), and therefore we expected that infants would show successful categorization of both happy and fearful expressions. When infants were habituated to happy facial expressions they demonstrated a significant novelty preference, however did not show a significant novelty preference when habituated to fearful facial expressions. Therefore, Study 1c replicated the order effect found in Studies 1a and 1b. This suggests that fearful expressions are not easier for infants to categorize when expressed by familiar female caregivers, which is contrary to the hypothesis that face familiarity would enhance infants' ability to categorize facial expressions of emotion. In Study 1c, the order effect did not seem to be due to differences in looking time during the habituation

phase, because habituation looking times did not differ for infants habituated to happy compared to fear.

Study 2 examined 8- and 9-month-old infants' ability to generalize across three unfamiliar female identities in order to categorize happy and fearful facial expressions varying in intensity (as in Study 1a). Infants demonstrated a significant novelty preference when habituated to happy facial expressions. This is not surprising because Studies 1a, 1b, and 1c revealed successful categorization of happy faces in 6-month-old infants. This result is also in accordance with previous results in 5- and 7-month-olds (Bornstein & Arterberry, 2003; Nelson & Dolgin, 1985). However, a significant novelty preference was not demonstrated when infants were habituated to fearful facial expressions. Therefore, Study 2 replicated the order effect found in Studies 1a, 1b, and 1c. This suggests that the ability to categorize fearful facial expressions is not present even in 8- and 9-month-old infants. This is surprising because it has previously been proposed that infants' emotion recognition abilities become increasingly sophisticated during the latter half of the first year (Nelson, 1987) and by 10 months of age infants begin demonstrating behavioural precursors of social referencing (Striano & Rochat, 2000). In Study 2, as in Studies 1a, 1b, and 1c, the order effect did not appear to be due to differences in looking time during the habituation phase, because habituation looking times did not differ for infants habituated to happy compared to fear.

Based on previous research (Kahana-Kalman & Walker-Andrews, 2001; Montague & Walker-Andrews, 2002; Walker-Andrews et al., 2011), our initial hypothesis was that familiarity with the individuals posing the facial expressions (e.g., infant caregivers—Study 1c) would

facilitate infants' ability to categorize facial expressions of emotion. We also predicted that using only one- intensity of emotion during habituation (Study 1b) would facilitate categorization and older infants would be more likely to demonstrate successful categorization (Study 2). However, we found the same pattern of results in all four studies; specifically, infants were able to categorize happy facial expressions but were not able to categorize fearful facial expressions. This discussion will provide theoretical evidence for why infants show difficulty categorizing fearful facial expressions and why the various manipulations did not facilitate this ability.

A prominent theory attempting to explain the order effects infants demonstrate when categorizing happy and fearful facial expressions is that fearful expressions are more novel relative to more positive facial expressions of emotion (de Haan et al., 2004; Malatesta & Haviland, 1982; Nelson & Dolgin, 1985; Nelson & Luddeman, 1988; Quinn et al., 2011). This theory emphasizes that infants are not exposed to fearful facial expressions of emotion as frequently as happy facial expressions, and therefore infants may have greater difficulty habituating to fearful facial expressions than happy facial expressions (Nelson & Dolgin, 1985). Malatesta and Haviland (1982) found that during mother-infant dyad play sessions, mother's facial expressions consisted of interest, joy, and surprise, which all conveyed positive emotion. Thus, it was suggested that infants might successfully demonstrate discrimination of positive emotions from negative emotions because they are exposed to positive emotions more frequently. Further, de Haan and colleagues (2004) investigated the role maternal emotional disposition played in 7-month-old infants' neural responses to neutral, fearful, and happy facial expressions of emotion, and also examined infants' visual preference for happy versus fearful

facial expressions. It was assumed that maternal emotional disposition would reflect infants' experience with different facial expressions (e.g., mothers who score high in negative emotionality may demonstrate more negative emotions towards their infants). Findings revealed that a subset of infants whose mothers demonstrated a positive emotional disposition showed a larger Nc amplitude in response to fearful as compared to happy facial expressions. The Nc is a negative-deflecting neural component that reflects greater allocation of attention to salient stimuli (Courchesne, Ganz, & Norcia, 1981). Further, these infants also demonstrated longer looking time towards fearful facial expressions than happy facial expressions. This preference for fearful facial expressions was not found for infants whose mothers demonstrated a negative emotional disposition. These results suggest that early experience with specific facial expressions may facilitate recognition later in infancy.

In support of the novelty hypothesis, there is evidence suggesting an enhanced orientation towards negative social stimuli in infancy (Hoehl et al., 2008; 2010; Leppanen & Nelson, 2012; Vaish, Grossman & Woodward, 2008). Specifically, a "range-frequency" theory accounting for a negativity bias in adults and infants has been proposed. This theory posits that most adults perceive their world in a positive manner, and therefore the occurrence of a negative event is pronounced due to its unexpectedness rather than its negativity. The "range-frequency" theory has been extended to possibly explain why the processing of negative stimuli emerges in the second half of the first year. It is argued that early in life infants are frequently exposed to positive facial expressions and positive events; however, during the second half of the first year, infants begin to gain experience with more negative facial expressions as they develop more

independent behaviours (e.g., crawling) and experience negative consequences (e.g., falling). Thus, the unexpectedness or novelty of infrequent presentations of negative facial expressions early in life may be the source of a negativity bias in these infants, resulting in enhanced attention towards negative stimuli in the latter half of the first year (Bertenthal & Campos, 1990; Vaish, Grossman & Woodward, 2008).

Considering that caregivers provide the earliest exemplars of different facial expressions to their infants, it is reasonable to expect that happy and fearful expressions posed by infants' caregivers would be less novel to their infants than happy and fearful facial expressions posed by unfamiliar individuals, and therefore, infants might be more able to habituate to fearful faces and demonstrate successful categorization of fearful faces. It is surprising that infants familiarized to their female caregivers expressing facial expressions (Study 1c), continued to demonstrate difficulty categorizing fearful expressions when posed by their caregivers. Moreover, considering that by 8 and 9 months of age infants demonstrate stranger anxiety (Schaffer, 1966) and demonstrate precursors to social referencing in potentially threating situations (Striano & Rochat, 2000), it is surprising that 8- and 9-month-olds demonstrated difficulty categorizing fearful facial expressions. According to the novelty hypothesis, unsuccessful categorization is explained by a lack of experience with fearful facial expressions at 8 and 9 months of age, which does not seem to be congruent with the demonstration of these sophisticated social abilities.

A theory challenging the novelty hypothesis emphasizes that infants' failure to categorize fearful facial expressions may not reflect an inability to recognize fearful emotion; instead, it may be an indication that infants recognize the underlying affective meaning of fearful facial

expressions. Infants may prefer to look longer towards fearful expressions as compared to happy expressions because fear may signal a potential source of threat (Leppanen & Nelson, 2009; Leppanen & Nelson, 2012; LoBue & DeLoache, 2010; Peltola et al., 2009; see Vaish, Grossman & Woodward, 2008). Peltola and colleagues (2009) investigated when in the first year infants begin to show greater allocation of attention towards fearful facial expressions versus happy facial expressions through the use of ERPs and looking time behaviour in a visual paired comparison task. Specifically, this was investigated at 5 and 7 months of age. Results revealed a greater Nc amplitude over the right hemisphere in 7-month-olds in response to fearful facial expressions; this finding was absent in 5-month-olds. Behavioural findings indicated that 7-month-olds looked significantly longer at fearful facial expressions as compared to happy facial expressions; this finding was also absent in 5-month-olds. These results suggested that differences in Nc amplitude in response to fearful facial expressions and longer preferential looking time towards fearful facial expressions at 7 months of age cannot be explained by the novelty hypothesis. This is because fearful facial expressions would be just as novel, if not more novel, to 5-month-olds as they would be to 7-month-olds, and no effects were found at 5 months of age. Instead, the authors suggested that differences in Nc amplitude and longer looking preferences at 7 months of age reflect the emergence of neural systems sensitive to the underlying meaning of fearful expressions. In support of this theory, research has revealed that young infants (neonates to 4 months) demonstrate a preference to look longer at happy facial expressions (Farroni et al., 2007; LaBarbera et al., 1976); however, older infants (7-month-olds) demonstrate a preference to look at fearful facial expressions (Nelson & Dolgin, 1985; Nelson &

Ludemann, 1988). Additionally, LoBue and DeLoache (2010) demonstrated increased attention to fearful stimuli; they found that 8- and 14-month-old infants oriented to photographs of snakes more rapidly than photographs of flowers, and orientated to angry facial expressions more quickly than happy facial expressions. Surprisingly, infants did not orient significantly faster to fearful than happy facial expressions; however, infants fixated on the fearful expressions for a longer time than the happy expressions. It was suggested that this might be due to the differences in emotional meaning conveyed by angry versus fearful expressions. Specifically, anger may evoke direct threat and aggression towards the observer, causing rapid orientation directly towards the threat source. Instead, fear may signify threat in the observer's environment, causing increased looking to determine the source of the threat. This evidence further suggests that it is not until the second half of the first year that infants demonstrate a visual preference for fearful facial expressions.

In further support of this theory, Peltola and colleagues (2008) investigated directly whether greater infant looking time toward fearful facial expressions at 7 months of age may be attributed to the novelty of fearful expressions. They examined 7-month-olds' looking preferences for fearful, neutral, and happy expressions, as well as a completely novel expression (i.e., blown up cheeks with wide open eyes). These were compared to a novel scrambled facial expression of emotion. They found that infants looked longer at fearful facial expressions than novel scrambled facial expressions; however, infants did not look longer at the completely novel expression versus the novel scrambled expression. Thus, the novelty of the facial expressions does not seem to be driving the preference for fearful faces. Peltola and colleagues (2008) also

investigated whether viewing fearful facial expressions may hinder infants' ability to shift their attention to a new location. Seven-month-old infants were shown either a fearful, happy, or the completely novel facial expression presented within their central field of view, followed by the presentation of a target within their peripheral field of view. Results revealed that infants demonstrated greater difficulty disengaging their attention from the fearful expressions than the happy or novel expressions. These results suggest that the novelty of fearful facial expressions may not be an adequate explanation for the greater looking time towards fearful facial expressions at 7 months of age. Additional evidence supporting the alternative hypothesis—that visual preference for fearful facial expressions at 7 months of age indicates the emergence of affective understanding—is found in measures of heart rate. Seven-month-olds demonstrate greater heart rate deceleration when presented with fearful as compared to happy facial expressions. Heart rate deceleration is suggested to reflect enhanced attention to stimuli signaling a potential source of threat (Peltola, Leppanen & Hietanen, 2011).

Additional evidence that infants' understanding of the underlying social meaning of fearful facial expressions emerges at 6 to 7 months of age comes from literature examining the development of social referencing in infancy and stranger anxiety (Hoehl et al., 2008; see Leppanen & Nelson, 2012;; Striano & Rochat, 2000; Schaffer, 1966; Vaish & Striano, 2004). Specifically, research has found that 7- to 10-month-old infants reference their caregivers or reference an adults' eye gaze direction when presented with a potentially threating situation (Hoehl et al., 2008; 2010; Striano & Rochat, 2000). This ability becomes increasingly sophisticated by 12 months of age, as infants reference their caregivers when deciding whether it

is safe to crawl across a visual cliff (Vaish & Striano, 2004). Moreover, the emergence of stranger-related fears are demonstrated at approximately 6 months of age (Mangelsdorf, 1992).

These results are also in accordance with limitations in the visual system and limitations in more general face-processing abilities in infants younger than 6 months of age (Atkinson, Braddick, & Moar, 1977; Caron et al., 1973; Maurer & Salapatek, 1976). As discussed earlier it is not until approximately 7 months that infants begin to perceive faces configurally, which may facilitate the recognition of the underlying affective meaning of fearful facial expressions (Kestebaum and Nelson; 1990).

Finally, more recent literature has suggested that there may be an early delay in fearful learning before the formation of attachment patterns. This argument is derived from work examining positive and negative associational learning and attachment patterns in rat pups. Specifically, during an early period (first 10 days of life) rat pups demonstrate a reduced aversion to negative or threat-related stimuli and therefore demonstrate difficulty learning avoidance behaviours in association with negative stimuli. It is theorized that this period is crucial for the development of attachment formation, regardless of positive or negative experiences with the caregiver. After this short period, when attachment patterns are established, rat pups begin to demonstrate typical avoidance behaviour toward aversive and threat evoking stimuli (see Leppanen & Nelson, 2012; see Sullivan & Holman, 2010). This potentially suggests a similar pattern of development in human infants; that is, an understanding of the affective meaning of fear may not develop until the second half of the first year in infancy to facilitate the development of infant-caregiver attachment.

Taken together, these results suggest that sometime around 7 months of age, infants begin to appreciate the signal value of fearful facial expressions, and this appreciation leads to longer looking at fearful facial expressions than other emotional expressions in various contexts. In the current studies, infants did not show a significant novelty preference after being habituated to fearful faces (i.e., they did not look longer at the happy face than the fearful face during the test phase). This lack of novelty preference may not reflect failure to recognize or categorize fearful facial expressions, but instead may indicate the emergence of an understanding of the social meaning of fearful facial expressions. Further, indirect evidence that 6-, 8- and 9-month-old infants may appreciate the emotional meaning of fear stems from attrition rates in response to infants habituated to fearful facial expressions as compared to happy facial expressions, in Studies 1a and 1c. In these studies, a greater number of infants habituated to fearful facial expressions did not complete the task due to fussiness. This suggests that infants were attending to the emotional meaning of fear in these conditions. Specifically, in Study 1c, it may have been unpleasant for infants to observe fearful facial expressions expressed by their caregivers.

Limitations

When interpreting the findings in the current series of studies, it is necessary to consider possible caveats that may have influenced the results. The first limitation was reduced statistical power as a result of small sample sizes in Studies 1a and 1c, in the fear condition (n=6 and n=5, respectively). This was due to a) a greater attrition rate in the fear condition in both studies, as mentioned earlier, and b) more difficulty posing fearful facial expressions than happy facial expressions by caregivers in Study 1c. Therefore, it is uncertain whether infants would have

demonstrated significant novelty preferences in the fear condition with a larger sample size. However, a greater number of infants were habituated to fearful facial expressions in Studies 1b and 2 (samples consisted of approximately the same number of infants habituated to both happy and fearful expressions) and a novelty preference was still not found in each of these studies in the fear condition. Therefore, it is unlikely that novelty preferences in the fear condition will be found in Studies 1a and 1c with a greater number of infants habituated to fearful facial expressions.

A second limitation, inherent to Study 1c, was difficulty conveying fearful facial expressions by infant caregivers. Although caregivers were provided with detailed information about the changes in the eye, brow, and mouth areas of the face specific to fearful expressions, were provided with a mirror and opportunity to practice fearful expressions, and were instructed to imagine threat-provoking scenarios (methods used in previous literature to evoke specific emotions in participants—Haviland & Lelwica, 1987), caregivers still demonstrated difficulty posing fearful facial expressions. Some caregivers had difficulty conveying an appropriate level of intensity for fearful expressions, as assessed subjectively by the experimenter, so in these cases infants were habituated to happy faces instead of fearful faces. Other caregivers had difficulty conveying fear rather than surprise. This latter difficulty was reflected in observers' validity ratings, as results demonstrated that observers often incorrectly labeled fear as surprise. Although it is possible that this difficulty influenced the current findings, it is unlikely. This is because previous literature has found that infants demonstrate successful categorization of surprised facial expressions and discriminate surprise from happy facial expressions, but do not

demonstrate successful categorization of fearful facial expressions at 7 months of age and discriminate fearful from happy facial expressions (Caron, Caron & Myers, 1982). Results in Study 1c reveal that 6-month-old infants were unable to categorize fearful facial expressions; this suggests that these expressions were actually perceived by infants as signaling negative (fear) rather than positive (surprise) affect.

A third limitation, also specific to Study 1c, was the substitution of an unfamiliar caregiver posing a happy or fearful facial expression during the habituation phase for infants who did not have more than three caregivers total that agreed to be photographed. Although unfamiliar caregivers were only presented to infants during the habituation phase, and were standardized and matched to the infant's ethnicity, these infants may have experienced more difficulty categorizing facial expressions than infants who were presented with all familiar caregivers during the habituation phase. In fact, infants who saw an unfamiliar caregiver during habituation did show a smaller novelty preference during the test trials (M= .54, SD= .11), compared to infants who saw familiar caregivers only (M= .57, SD= .06). Although this difference was not significant, $t(11)$= .66, p=.53, the small sample size may have decreased the likelihood that we could find a significant difference, and so it remains possible that seeing an unfamiliar caregiver during habituation made it less likely that infants would demonstrate successful categorization of fearful facial expressions. Future testing will focus on recruiting infants who have four caregivers that agree to participate in the study.

A fourth limitation was the use of a self-report questionnaire to assess the amount of time interacting with caregivers and the quality of interactions caregivers shared with their infants.

Specifically, for some parents it was difficult to report approximately the amount of time their infants spent interacting with other caregivers during a typical interaction because the time greatly varied. Further, it was difficult for parents to assess how often infants interacted with other caregivers in unique situations, such as infants who gained frequent exposure to caregivers over the course of a few days per month or who only interacted with caregivers through the computer (e.g., Skype interactions). Moreover, in some cases parents reported difficulty assessing how often infants were exposed to public places and unfamiliar individuals, as the amount of time greatly varied. Standard weaknesses of self-report measures that bias questionnaire results should also be considered, such as a social-desirability bias (e.g., if a parent is neglectful to their infant, it may be unlikely this would be reported), or parent feelings at the time of completion, which may have affected primary caregivers' answers (Podsakoff et al., 2003). Given that the primary purpose of collecting infant-caregiver interaction data was to explore possible associations between infants' ability to successfully categorize facial expressions (happy and fear) and the amount/quality of interactions with their primary caregivers, other caregivers and unfamiliar individuals/public places, it is possible that the lack of significant findings here reflected these difficulties with the questionnaire. Since the questionnaire was designed to obtain data for exploratory purposes only, the Infant-Caregiver Interaction scale was not validated.

Finally, a fifth limitation was the restriction of stimuli from different ethnic groups within the NimStim Face Stimulus Set (Tottenham et al., 2009). Due to this restriction, only two ethnicity conditions of the experiments (Caucasian and Asian) could be created and presented to

infants. Thus, infants from ethnic groups other than Caucasian or Asian may have experienced greater difficulty categorizing facial expressions. In Studies 1a, 1b, and 2, approximately 25% of parents did not classify their infants as belonging to Caucasian or Asian ethnic groups. Research examining emotion recognition in adults has found higher recognition accuracy for individuals posing facial expressions of the same ethnic group as compared to than other ethnic groups (see Elfenbein & Ambady, 2002). However, no literature has examined this ability in 6-month-old and 8- and 9-month-old infants, and so it is uncertain whether this limitation may have affected infants' categorization ability.

Future Directions and Conclusions

With regards to future research, it would be of interest to examine 3-month-old infants' ability to generalize across unfamiliar females' identities or female caregivers' identities in order to categorize happy and fearful facial expressions. According to the theory that a fear preference develops between 6 and 7 months of age when infants begin to understand the underlying affective meaning of fear, it would be expected that 3-month-old infants would not demonstrate this fear preference. In other words, 3-month-olds should demonstrate greater proportion looking time toward the novel facial expression (happy) after being habituated to fearful facial expressions posed by unfamiliar individuals (i.e., successful categorization of fearful expressions). If person familiarity facilitates infants' ability to recognize facial expressions as revealed in previous research (Kahana-Kalman & Walker-Andrews, 2001; Walker-Andrews et al., 2011), then it would be expected that 3-month-old infants habituated to their caregivers expressing fearful facial expressions should demonstrate this fear preference and not demonstrate

a novelty preference toward the happy facial expression. This pattern of results would suggest that 3-month-olds recognize the underlying affective meaning of fear, but only when it is expressed by their caregivers.

In conclusion, overall results revealed that at 6, 8, and 9 months of age infants successfully categorize happy facial expressions of emotion and demonstrate a looking preference towards fearful facial expressions. Studies 1a and 1b are the first to investigate the ability to categorize fearful facial expressions and discriminate them from happy facial expressions in infants younger than 7 months of age. Results demonstrated are consistent with previous studies of 7-month-olds. Study 1c was the first to investigate the facilitating effect of familiarity on the ability to categorize the facial expressions of happy and fear across identity, and demonstrated that familiarity does not facilitate successful categorization of fearful faces. Finally, Study 2 was the first to examine categorization of happy and fearful expressions in infants older than 7 months of age, and replicated the pattern of results in 6- and 7-month-old infants. These results augment previous literature by elucidating the time course by which infants are able to successfully categorize happy and fearful expressions when expressed by unfamiliar female identities, and the timeframe by which infants may begin to understand the emotional significance of fearful facial expressions. Further, these findings shed light on the role person familiarity plays in infants' ability to achieve these important social milestones. These findings add to our understanding of the development of later social abilities (e.g., emotion regulation) and may be applied to better understand the development of infants diagnosed with particular developmental disorders in which emotion recognition is disrupted. For example, it is suggested

that children with autism may be insensitive to facial expressions as compared to typically developing children (Weeks & Hobson, 1987). Results from the four current studies may contribute to the development of early diagnostic criteria to be used in clinical settings.

Appendix A

Ryerson University
Consent Agreement: Studies 1a, 1b and 2

Recognizing Facial Expressions of Emotion in Infancy: The Role of Face Familiarity

You and your infant are being asked to participate in a research study. Before you give your consent to be a volunteer, it is important that you read the following information and ask as many questions as necessary to be sure you understand what you will be asked to do.

Investigators: This study is being conducted by Kristina Safar, a Master's student in the Department of Psychology at Ryerson University. The research supervisor on this project is Margaret Moulson, PhD, director of the Brain and Early Experiences (BEE) Lab in the Department of Psychology at Ryerson University.

Purpose of the Study:
Facial expressions of emotion are one of the first ways in which infants interact and communicate with their caregivers. The ability to discriminate between facial expressions is fundamental for the development of caregiver relationships, regulation of emotions and later social skills. Therefore, it is essential to fully understand an infant's ability to perceive facial expressions. However, it is unclear when during infancy this ability develops, and we do not know whether previous experience with specific faces, such as caregivers, may affect discrimination ability. In this study, using a looking time paradigm, we will examine whether 6-month-old and 8 and 9-month-old infants can discriminate between facial expressions when posed by different strangers, and when posed by different caregivers.

One hundred and sixty infants and their parents/legal guardians are being recruited to participate in this study. You and your infant were identified as possible participants in this study because your infant is currently within our age range (6 or 8- and 9-months of age), and you had previously expressed interest in participating in developmental research studies at Ryerson University.

Description of the Study: In this study, your infant will complete a looking time procedure that has two phases: a habituation phase and a test phase. During both phases, your infant will be sitting on your lap in front of a computer screen so that he/she can watch photographs of *unfamiliar* female faces posing facial expressions (a different group of infants will see photographs of *familiar* female faces posing facial expressions). During the *habituation* phase, we will show your infant several different unfamiliar faces posing the same facial expression. We will show these photographs until your infant becomes bored of watching them (your infant will show us he/she is bored by looking away from the photographs). After your infant has become bored during the habituation phase, the test phase will begin. During the *test* phase, we will show your infant two new photographs. In one of the photographs, a new unfamiliar face

will be posing the facial expression seen during the habituation phase; in the other photograph, the new unfamiliar face will be posing a new facial expression not seen before in the habituation phase. While your infant is completing the study, we will be video recording him/her so that we can measure how long he/she looks at each photograph.

This study is a one-time visit only, and will take place here in the Brain and Early Experiences (BEE) Lab, in a separate room. You will remain with your infant at all times throughout the study. The entire study session will take approximately 30 minutes, but the looking time procedure itself will only take about 10 minutes.

What is Experimental in this Study: None of the procedures used in this study are experimental in nature, in the sense that they are commonly used by other researchers and have been found to be useful procedures for understanding infant development. From a technical or procedural point of view, part of this study is considered "experimental," because the looking time procedure described above examines the impact of one variable (called the "independent variable" – in this case, new vs. old facial expression) on another variable (called the "dependent variable" – in this case, infant looking time).

Risks or Discomforts: It is possible that your infant may become bored or fussy while participating in this study, but no more than he/she might during day-to-day life. You are allowed to take breaks at any time you wish if your infant is becoming bored or fussy while viewing the photographs, and you can take as long as you need to settle him/her before we continue with the study. Additionally, you can discontinue the study at any point if you feel uncomfortable for any reason, or if your infant has become too tired or fussy to continue with it.

Benefits of the Study: There are no direct benefits to you or your infant for participating in this study. However, parents who have participated in similar studies conducted by the research supervisor, Dr. Margaret Moulson, have generally reported that it was a fun and interesting experience. Additionally, this study will contribute to the scientific community by advancing our understanding of infants' perception of facial expressions of emotion.

Confidentiality: All of the information that we collect from you and your infant during this study will remain confidential. Your infant will be assigned a participant ID number, and any written notes we take and the videotape of the study session will be identified only by this participant ID number. This material will be stored in locked filing cabinets in the BEE Lab, and stored separately from this consent form. All electronic copies of your information will be stored on password-protected computers in the BEE Lab. Only those researchers directly involved in this study will have access to your information, including the videotape of the study session. The data and videotape will be stored for as long as required by the ethical and publication guidelines of psychology (generally 5 years following publication of the findings), after which time it will be destroyed.

Incentives to Participate: For participating in this study, your infant will receive a small gift (e.g., a toy) at the end of the study session. Even if you decide not to participate in this study, or discontinue participation partway through the study, your infant will still receive the gift as a token of our appreciation for coming in to the lab.

Costs of Participation: There are transportation costs associated with participating in this study, due to your travel to the BEE Lab from your home. These costs will vary depending on your method of transportation, but will generally not exceed $10. These costs will not be compensated. However, if you drove to campus, you will be compensated for your parking costs on Ryerson campus.

Voluntary Nature of Participation: Participation in this study is voluntary. Your choice of whether or not to participate will not influence your future relations with Ryerson University. If you decide to participate, you are free to withdraw your consent and to stop your participation at any time without penalty or loss of benefits to which you are allowed.

At any particular point in the study, you may refuse to answer any particular question or stop participation altogether.

Questions about the Study: If you have any questions about the research now or during the study session, please ask. If you have questions later about the research, you may contact:

Principal Investigator: Kristina Safar, Master's student, Department of Psychology
Telephone Number: 416-979-5000 x2189

Research Supervisor: Margaret Moulson, Ph.D., Department of Psychology
Telephone Number: 416-979-5000 x2661

If you have questions regarding your rights as a human subject and participant in this study, you may contact the Ryerson University Research Ethics Board for information.

Research Ethics Board
c/o Office of the Vice President, Research and Innovation
Ryerson University
350 Victoria Street
Toronto, ON M5B 2K3
416-979-5042

Agreement:

Your signature below indicates that you have read the information in this agreement and have had a chance to ask any questions you have about the study. Your signature also indicates that you agree to have your infant participate in the study and be videotaped, and that you have been

told that you can change your mind and withdraw your consent to participate at any time. You have been given a copy of this agreement.

You have been told that by signing this consent agreement you are not giving up any of your legal rights.

_____ _____

Name of Parent/Guardian of Participant (please print) Name of Infant (please print)

_____ _____

Signature of Parent/Guardian of Participant Date

_____ _____

Signature of Investigator Date

Appendix B

Ryerson University
Consent Agreement: Study 1c

Recognizing Facial Expressions of Emotion in Infancy: The Role of Face Familiarity

You and your infant are being asked to participate in a research study. Before you give your consent to be a volunteer, it is important that you read the following information and ask as many questions as necessary to be sure you understand what you will be asked to do.

Investigators: This study is being conducted by Kristina Safar, a Master's student in the Department of Psychology at Ryerson University. The research supervisor on this project is Margaret Moulson, PhD, director of the Brain and Early Experiences (BEE) Lab in the Department of Psychology at Ryerson University.

Purpose of the Study: Facial expressions of emotion are one of the first ways in which infants interact and communicate with their caregivers. The ability to discriminate between facial expressions is fundamental for the development of caregiver relationships, regulation of emotions and later social skills. Therefore, it is essential to fully understand an infant's ability to perceive facial expressions. However, it is unclear when during infancy this ability develops, and we do not know whether previous experience with specific faces, such as caregivers, may affect discrimination ability. In this study, using a looking time paradigm, we will examine whether 6-month-old infants can discriminate between facial expressions when posed by different strangers, and when posed by different caregivers.

One hundred and sixty infants and their parents/legal guardians are being recruited to participate in this study. You and your infant were identified as possible participants in this study because your infant is currently within our age range (6 months of age), and you had previously expressed interest in participating in developmental research studies at Ryerson University.

Description of the Study: In this study, your infant will complete a looking time procedure that has two phases: a habituation phase and a test phase. During both phases, your infant will be sitting on your lap in front of a computer screen so that he/she can watch photographs of *familiar* female faces posing facial expressions (a different group of infants will see photographs of *unfamiliar* female faces posing facial expressions). During the *habituation* phase, we will show your infant several different familiar faces posing the same facial expression. We will show these photographs until your infant becomes bored of watching them (your infant will show us he/she is bored by looking away from the photographs). After your infant has become bored during the habituation phase, the test phase will begin. During the *test* phase, we will show your infant two new photographs. In one of the photographs a new familiar face will be posing the facial expression seen during the habituation phase; in the other photograph the new familiar face will be posing a new facial expression not seen before in the habituation phase. While your infant is

completing the study, we will be video recording him/her so that we can measure how long he/she looks at each photograph.

This study is a one-time visit only, and will take place here in the Brain and Early Experiences (BEE) Lab, in a separate room. You will remain with your infant at all times throughout the study. The entire study session will take approximately 30 minutes, but the looking time procedure itself will only take about 10 minutes.

What is Experimental in this Study: None of the procedures used in this study are experimental in nature, in the sense that they are commonly used by other researchers and have been found to be useful procedures for understanding infant development. From a technical or procedural point of view, part of this study is considered "experimental," because the looking time procedure described above examines the impact of one variable (called the "independent variable" – in this case, new vs. old facial expression) on another variable (called the "dependent variable" – in this case, infant looking time).

Use of Photographs in this Study: This study will require us to photograph your infant's female caregivers. Photographs will be used as stimuli during the study session and therefore be shown to your infant. The use of photographs in this study is necessary to determine whether your infant can discriminate between familiar facial expressions. Photographs will be viewed by individuals directly involved in this study, and may be viewed for possible publication, future teaching or training purposes. Photographs will be identified only by a participant ID number, will be stored separately from the participant consent forms, and will be accessed only by those individuals directly involved in the study.

Risks or Discomforts: It is possible that your infant may become bored or fussy while participating in this study, but no more than he/she might during day-to-day life. You are allowed to take breaks at any time you wish if your infant is becoming bored or fussy while viewing the photographs, and you can take as long as you need to settle him/her before we continue with the study. Additionally, you can discontinue the study at any point if you feel uncomfortable for any reason, or if your infant has become too tired or fussy to continue with it.

Benefits of the Study: There are no direct benefits to you or your infant for participating in this study. However, parents who have participated in similar studies conducted by the research supervisor, Dr. Margaret Moulson, have generally reported that it was a fun and interesting experience. Additionally, this study will contribute to the scientific community by advancing our understanding of infants' perception of facial expressions of emotion.

Confidentiality: All of the information that we collect from you and your infant during this study will remain confidential. Your infant will be assigned a participant ID number, and any written notes we take, photographs, and the videotape of the study session will be identified only by this participant ID number. This material will be stored in locked filing cabinets in the BEE

Lab, and stored separately from this consent form. All electronic copies of your information will be stored on password-protected computers in the BEE Lab. Only those researchers directly involved in this study will have access to your information, including the videotape of the study session. The data, videotape, and photographs will be stored for as long as required by the ethical and publication guidelines of psychology (generally 5 years following publication of the findings), after which time they will be destroyed.

Incentives to Participate: For participating in this study, your infant will receive a small gift (e.g., a toy) at the end of the study session. Even if you decide not to participate in this study, or discontinue participation partway through the study, your infant will still receive the gift as a token of our appreciation for coming in to the lab.

Costs of Participation: There are transportation costs associated with participating in this study, due to your travel to the BEE Lab from your home. These costs will vary depending on your method of transportation, but will generally not exceed $10. These costs will not be compensated. However, if you drove to campus, you will be compensated for your parking costs on Ryerson campus.

Voluntary Nature of Participation: Participation in this study is voluntary. Your choice of whether or not to participate will not influence your future relations with Ryerson University. If you decide to participate, you are free to withdraw your consent and to stop your participation at any time without penalty or loss of benefits to which you are allowed.

At any particular point in the study, you may refuse to answer any particular question or stop participation altogether.

Questions about the Study: If you have any questions about the research now or during the study session, please ask. If you have questions later about the research, you may contact:

Principal Investigator: Kristina Safar, Master's student, Department of Psychology
Telephone Number: 416-979-5000 x2189

Research Supervisor: Margaret Moulson, Ph.D., Department of Psychology
Telephone Number: 416-979-5000 x2661

If you have questions regarding your rights as a human subject and participant in this study, you may contact the Ryerson University Research Ethics Board for information.

Research Ethics Board
c/o Office of the Vice President, Research and Innovation
Ryerson University
350 Victoria Street
Toronto, ON M5B 2K3
416-979-5042

Agreement:

Your signature below indicates that you have read the information in this agreement and have had a chance to ask any questions you have about the study. Your signature also indicates that you agree to have your infant participate in the study and be videotaped, and that you have been told that you can change your mind and withdraw your consent to participate at any time. You have been given a copy of this agreement.

You have been told that by signing this consent agreement you are not giving up any of your legal rights.

_____

Name of Parent/Guardian of Participant (please print) Name of Infant (please print)

_____ _____

Signature of Parent/Guardian of Participant Date

_____ _____

Signature of Investigator Date

Appendix C

Demographic Questionnaire

Demographic Information
Participant number_____

Date _____

Please fill out the following demographic information:

1. Infant's birthdate _____

2. Infant's race/ethnicity (please check all applicable):

- ☐ Asian
- ☐ Black/African American
- ☐ Middle Eastern
- ☐ Hispanic
- ☐ Caucasian
- ☐ Other (Please specify) _____

3. Was the infant born full- term (born +/- 2 weeks from the expected due date)?

- ☐ Yes
- ☐ No, please specify how many weeks before or after expected due date infant was born _____

4. Was the infant diagnosed with any clinical disorders? (i.e. pervasive developmental disorders, mental retardation, fetal alcohol spectrum disorders)

   - ☐ Yes
   - ☐ No

5. Was the infant diagnosed with any visual impairment?

   - ☐ Yes
   - ☐ No

Appendix D

Infant-Caregiver Interaction Questionnaire

Infant-Caregiver Interaction Scale Participant number_____

Part A: Please fill out the following information regarding YOUR interactions with your infant.

1a. What is your relation to the infant (please check one)?
- ☐ Mother
- ☐ Father
- ☐ Legal Guardian

2a. Your race (please check all applicable):
- ☐ Asian
- ☐ Black/African American
- ☐ Middle Eastern
- ☐ Hispanic
- ☐ Caucasian
- ☐ Other (Please specify) _____

4a. How many days per week does the infant interact with you (please check one)?

- ☐ 1-2 days
- ☐ 3-4 days
- ☐ 5-7 days

5a. On average, what is the amount of time that the infant spends interacting with you during a typical interaction (please check one)?

- ☐ Less than 10 minutes
- ☐ Approximately half an hour
- ☐ Approximately one hour
- ☐ Greater than one hour

6a. On average, what types of interactions does the infant typically have with you (please check one)?

- ☐ Non-direct interaction
- ☐ Direct brief interaction
- ☐ Direct interaction involving play with the infant
- ☐ Direct interaction during feeding, changing and other necessary caregiver activities and involving play with the infant

- ☐ Direct interaction during feeding, changing and other necessary caregiver activities and not involving play with the infant
- ☐ Other (please specify) _____

Part B: Please fill out the following questionnaires about the THREE other caregivers with whom the infant interacts the most during a typical week.

Caregiver 1:

1b. What is the caregiver's relation to the infant (please check one)?

- ☐ Mother
- ☐ Father
- ☐ Grandmother
- ☐ Grandfather
- ☐ Aunt
- ☐ Uncle
- ☐ Cousin
- ☐ Great-grandparent
- ☐ Nanny
- ☐ Baby sitter
- ☐ Family friend
- ☐ Other (Please specify) _____

2b. Caregiver's race (please check all applicable):

- ☐ Asian
- ☐ Black/African American
- ☐ Middle Eastern
- ☐ Hispanic
- ☐ Caucasian
- ☐ Other (Please specify) _____

4b. How many days per week does the infant interact with this caregiver (please check one)?

- ☐ 1-2 days
- ☐ 3-4 days
- ☐ 5-7 days

5b. On average, what is the amount of time that the infant spends interacting with this caregiver during a typical interaction (please check one)?

- ☐ Less than 10 minutes
- ☐ Approximately half an hour
- ☐ Approximately one hour

- ☐ Greater than one hour

6b. On average, what types of interactions does the infant typically have with this caregiver (please check one)?

- ☐ Non-direct interaction
- ☐ Direct brief interaction
- ☐ Direct interaction involving play with the infant
- ☐ Direct interaction during feeding, changing and other necessary caregiver activities and involving play with the infant
- ☐ Direct interaction during feeding, changing and other necessary caregiver activities and not involving play with the infant
- ☐ Other (please specify) _____

Caregiver 2:

1c. What is the caregiver's relation to the infant (please check one)?

- ☐ Mother
- ☐ Father
- ☐ Grandmother
- ☐ Grandfather
- ☐ Aunt
- ☐ Uncle
- ☐ Cousin
- ☐ Great-grandparent
- ☐ Nanny
- ☐ Baby sitter
- ☐ Family friend
- ☐ Other (Please specify) _____

2c. Caregiver's race (please check all applicable):

- ☐ Asian
- ☐ Black/African American
- ☐ Middle Eastern
- ☐ Hispanic
- ☐ Caucasian
- ☐ Other (Please specify) _____

4c. How many days per week does the infant interact with this caregiver (please check one)?

- ☐ 1-2 days
- ☐ 3-4 days
- ☐ 5-7 days

5c. On average, what is the amount of time that the infant spends interacting with this caregiver during a typical interaction (please check one)?

- ☐ Less than 10 minutes
- ☐ Approximately half an hour
- ☐ Approximately one hour
- ☐ Greater than one hour

6c. On average, what types of interactions does the infant typically have with this caregiver (please check one)?

- ☐ Non-direct interaction
- ☐ Direct brief interaction
- ☐ Direct interaction involving play with the infant
- ☐ Direct interaction during feeding, changing and other necessary caregiver activities and involving play with the infant
- ☐ Direct interaction during feeding, changing and other necessary caregiver activities and not involving play with the infant
- ☐ Other (please specify) _____

Caregiver 3:

1d. What is the caregiver's relation to the infant (please check one)?

- ☐ Mother
- ☐ Father
- ☐ Grandmother
- ☐ Grandfather
- ☐ Aunt
- ☐ Uncle
- ☐ Cousin
- ☐ Great-grandparent
- ☐ Nanny
- ☐ Baby sitter
- ☐ Family friend
- ☐ Other (Please specify) _____

2d. Caregiver's race (please check all applicable):

- ☐ Asian
- ☐ Black/African American
- ☐ Middle Eastern
- ☐ Hispanic
- ☐ Caucasian
- ☐ Other (Please specify) _____

4d. How many days per week does the infant interact with this caregiver (please check one)?

- ☐ 1-2 days
- ☐ 3-4 days
- ☐ 5-7 days

5d. On average, what is the amount of time that the infant spends interacting with this caregiver during a typical interaction (please check one)?

- ☐ Less than 10 minutes
- ☐ Approximately half an hour
- ☐ Approximately one hour
- ☐ Greater than one hour

6d. On average, what types of interactions does the infant typically have with this caregiver (please check one)?

- ☐ Non-direct interaction
- ☐ Direct brief interaction
- ☐ Direct interaction involving play with the infant
- ☐ Direct interaction during feeding, changing and other necessary caregiver activities and involving play with the infant
- ☐ Direct interaction during feeding, changing and other necessary caregiver activities and not involving play with the infant
- ☐ Other (please specify) _____

Part C: Please fill out the following information regarding the infant's interactions with unfamiliar people.

1e. How many days per week does the infant visit public places (e.g., malls, parks, daycare, etc.) (please check one)?

- ☐ 1-2 days
- ☐ 3-4 days
- ☐ 5-7 days

2e. How many days per week does the infant interact with unfamiliar people (please check one)?

- ☐ 1-2 days
- ☐ 3-4 days

- ☐ 5-7 days

3e. On average, what types of interactions does the infant typically have with unfamiliar people (please check one)?

- ☐ Non-direct interaction
- ☐ Direct brief interaction
- ☐ Direct interaction involving play with the infant
- ☐ Direct interaction during feeding, changing and other necessary caregiver activities and involving play with the infant
- ☐ Direct interaction during feeding, changing and other necessary caregiver activities and not involving play with the infant
- ☐ Other (please specify) _____

4e. On average, what is the amount of time that the infant spends interacting with unfamiliar people during a typical interaction (please check one)?

- ☐ Less than 10 minutes
- ☐ Approximately half an hour
- ☐ Approximately one hour
- ☐ Greater than one hour

Appendix E

De-briefing Form

Debriefing Form

Recognizing Facial Expressions of Emotion in Infancy: The Role of Face Familiarity

You have participated in a study conducted by Kristina Safar and Dr. Margaret Moulson, from the Department of Psychology at Ryerson University, Toronto, Ontario.

Background Information: Facial expressions of emotion are one of the first ways in which infants interact and communicate with their caregivers. The ability to discriminate between facial expressions is fundamental for the development of caregiver relationships, regulation of emotions and later social skills. Therefore, it is essential to fully understand an infant's ability to perceive facial expressions. However, it is unclear when during infancy this ability develops, and we do not know whether previous experience with specific faces, such as caregivers, may affect discrimination ability.

Purpose of the Study: The purpose of this study is to examine whether 6-month-old and 8-and 9-month-old infants can discriminate between facial expressions when posed by different strangers, and when posed by different caregivers, through the use of a looking time paradigm. You and your infant were identified as possible participants in this study because your infant is currently within our age range (6 months of age or 8 and 9 months of age), and you had previously expressed interest in participating in developmental research studies at Ryerson University. This research will serve to contribute to the scientific community by advancing our understanding of infants' perception of facial expressions of emotion

Design of the Study: In this study, your infant completed a looking time procedure that had two phases: a habituation phase and a test phase. During the *habituation* phase, we showed your infant many photographs (your infant saw either different unfamiliar faces posing the same facial expression or different familiar faces posing the same facial expression). We showed these photographs until your infant became bored of watching them (your infant showed us he/she was bored by looking away from the photographs). After your infant had become bored during the habituation phase, the test phase began. During the *test* phase, we showed your infant two new photographs, of two different unfamiliar or familiar faces. In one of the photographs the unfamiliar or familiar face had posed a facial expression seen before in the habituation phase. In the other photograph the unfamiliar or familiar face had posed a new facial expression not seen before in the habituation phase. While your infant was completing the study, we video recorded him/her in order to measure how long he/she looked at each photograph.

Questions and Concerns: If you have any questions about this study or would like to remove your child's data from the study, please contact one of the investigators stated at the top of the page. You may also contact us at any time.

Kristina Safar (416) 979-5000 ext. 2189 ksafar@psych.ryerson.ca

Dr. Margaret Moulson (416) 979-5000 ext. 2661 mmoulson@psych.ryerson.ca

If you having any questions regarding your rights as a human subject and participant in this study, you may contact the Ryerson University Research Ethics Board for information:

Research Ethics Board
c/o Office of the Vice President, Research and Innovation
Ryerson University
350 Victoria Street
Toronto, ON M5B 2K3
416-979-5042

Appendix F

Photo Release Form: Study 1c

Ryerson University
Photo Release Form

Recognizing Facial Expressions of Emotion in Infancy: The Role of Face Familiarity

You are being asked to provide consent for photographs of yourself to be used in a research study. Before you give your consent to be a volunteer, it is important that you read the following information and ask as many questions as necessary to be sure you understand what you will be asked to do.

Investigators: This study is being conducted by Kristina Safar, a Master's student in the Department of Psychology at Ryerson University. The research supervisor on this project is Margaret Moulson, PhD, director of the Brain and Early Experiences (BEE) Lab in the Department of Psychology at Ryerson University.

Purpose of the Study: Facial expressions of emotion are one of the first ways in which infants interact and communicate with their caregivers. The ability to discriminate between facial expressions is fundamental for the development of caregiver relationships, regulation of emotions and later social skills. Therefore, it is essential to fully understand an infant's ability to perceive facial expressions. However, it is unclear when during infancy this ability develops, and we do not know whether previous experience with specific faces, such as caregivers, may affect discrimination ability. In this study, using a looking time paradigm, we will examine whether 6-month-old infants can discriminate between facial expressions when posed by different strangers, and when posed by different caregivers.

Use of Photographs in this Study: In this study, infants will see photographs of familiar female faces posing facial expressions. Therefore, this study requires us to photograph the female caregivers of infants who participate in this study. These photographs will then be used as stimuli during the study. The use of photographs in this study is necessary to determine whether infants can discriminate between facial expressions when they are expressed by familiar people. Your photographs will be viewed only by the participants in this study and researchers directly involved in this study. If you agree, they may also be used in future publications or conference presentations. To ensure confidentiality, photographs will be identified only by a participant ID number, will be stored on password-protected computers in the BEE Lab at Ryerson, and will be accessed only by those researchers directly involved in the study. The photographs will be stored for as long as required by the ethical and publication guidelines of psychology (generally 5 years following publication of the findings), after which time they will be destroyed.

Agreement to the Capture and Use of Photographs:

Your signature(s) below indicates that you have read the description above regarding the capture and use of photographs in this study and have had a chance to ask any questions you have. Your signature(s) also indicates that you agree to be photographed, have your photographs used as stimuli in this study, and have your photographs used in future publications or conference presentations. You have been told that you can change your mind and withdraw your consent at any time. You have been given a copy of this agreement. You have been told that by signing this agreement you are not giving up any of your legal rights.

_____
Name of Individual (please print)

Agreement for Capture and Use of Photographs as Stimuli:

_____ _____
Signature of Individual Date

_____ _____
Signature of Investigator Date

Agreement for Use of Photographs in Future Publications/Conference Presentations:

_____ _____
Signature of Individual Date

_____ _____
Signature of Investigator Date

References

Abelson, R.P., & Sermat, V. (1962). Multidimensional scaling of facial expressions. *Journal of Experimental Psychology, 63*, 546-554.

Adolphs, R. (2002). Recognizing emotion from facial expressions: Psychological and neurological mechanisms. *Behavioral and Cognitive Neuroscience Reviews, 1*, 20-62.

Andrew, R.J. (1963). Evolution of facial expression. *Science, 142,* 1034-1041.

Barrera, M.E., & Maurer, D. (1981). The perception of facial expressions by the three-month-old. *Child Development, 52,* 203-206.

Bertenthal, B.I., & Campos, J.J. (1990). A systems approach to the organizing effects of self-produced locomotion during infancy. *Advances in Infancy, 6*, 1-60.

Bimler, D. & Kirklan, J. (2001). Categorical perception of facial expressions of emotion: Evidence from multidimensional scaling. *Cognition and Emotion, 15,* 633-658.

Bornstein, M. H., & Arterberry, M. E. (2003). Recognition, discrimination, and categorization of smiling by 5-month-old infants. *Developmental Science, 6,* 585-599.

Bowlby, J. (1982). *Attachment and loss. Vol. I: Attachment* (2nd ed.). New York: Basic (Original work published 1969).

Brosch, T., Pourtois, G., & Sander, D. (2010). The perception and categorisation of emotional stimuli: A review. *Cognition and Emotion, 3*, 377-400.

Bullock, M., & Russell, J.A. (1984). Preschool children's interpretation of facial expressions of emotion. *International Journal of Behavioral Development, 7*, 193-214.

Calder, A.J., Young, A.W., Perrett, D.I., Etcoff, N.L., & Rowland, D. (1996). Categorical perception of morphed facial expressions. *Visual Cognition, 3*, 101-37.

Camras, L. A., Oster, H. O., Campos, J., Miyake, K., & Bradshaw, D. (1992). Japanese and American infants responses to arm restraint. *Developmental Psychology, 28,* 578-583.

Caron, R.F., Caron, A.J., & Myers, R.S. (1982). Abstraction of invariant face expressions in infancy. *Child Development, 53,* 1008-1015.

Caron, R.F., Caron, A.J., & Myers, R.S. (1985). Do infants see emotional expressions in static faces? *Child Development, 56*, 1552-1560.

Caron, A.J., Caron, R.F., Caldwell, R.C., & Weiss, S.J. (1973). Infant perception of the structural properties of the face. *Developmental Psychology, 9,* 385-399.

Cashon, C.H., & Cohen, L.B. (2004). Beyond U-shaped development in infants' processing of faces: An information-processing account. *Journal of Cognition and Development, 5,* 59-80.

Chevalier-Skolnikoff, S. (2006). Facial expression of emotion in nonhuman primates. In P. Ekman (Ed.), *Darwin and facial expression* (2nd ed., pp. 11-83). California: Malor Books.

Cohen, L.B., Atkinson, D., Chaput, H.H. (2004). Habit X: A new program for obtaining and organizing data in infant perception and cognition studies (Version 1.0) [Computer software]. Austin: University of Texas.

Cohen, J. F., Campbell, S. B., & Ross, S. (1991). Infant response in the still-face paradigm at 6 months predicts avoidant and secure attachment at 12 months. *Development and Psychopathology, 3,* 367-376.

Cohen, L.B., & Cashon, C.H. (2001). Do 7-month-old infants process independent features or facial configurations? *Infant and Child Development, 10,* 83-92.

Courchesne, E., Ganz, L., & Norcia, A.M. (1981). Event-related brain potentials to human faces in infants. *Child Development, 52*, 804-811.

Darwin, C. (1998). *The expression of the emotions in man and animals,* (3rd ed.). New York: Oxford University Press. (Original work published 1872).

de Gelder, B., Teunisse, J., & Benson, P.J. (1997). Categorical perception of facial expressions: Categories and their internal structure. *Cognition and Emotion, 11*, 1-23.

de Haan, M., Belsky, J., Reid, V., Volein, A., & Johnson, M.H. (2004). Maternal personality and infants' neural and visual responsively to facial expressions of emotion. *Journal of Child Psychology and Psychiatry, 45*, 1209-1218.

Ekman, P. (1970). Universal facial expressions of emotion. *California Mental Health Research Digest, 8,* 151-158.

Ekman, P. (1972). Universals and cultural differences in facial expressions of emotion. In J. Cole (ed.). *Nebraska Symposium on Motivation*, 1971. Lincoln: University of Nebraska Press, pp. 207-283.

Ekman, P. (1989). The argument and evidence about universals in facial expressions of emotion. In H. Wagner & A. Manstead (Eds.), *Handbook of social psychophysiology* (pp. 143-164). Chichester, England: Wiley.

Ekman, P. (1992a). Are there basic emotions? *Psychological Review, 99,* 550-553.

Ekman, P. (1992b). An argument for basic emotions. *Cognition and Emotion, 6*, 169-200.

Ekman, P. (1993). Facial expression and emotion. *American Psychologist, 48*, 384-392.

Ekman, P. (1998). Introduction. In C. Darwin (1872/1998), *The expression of the emotions in man and animals.* (pp. xxi-xxxvi). New York: Oxford University Press.

Ekman, P. (1999). Facial expressions. In T. Dalgleish, & M. Power. *Handbook of cognition and emotion* (pp. 301-320). United Kingdom: John Wiley & Sons, Ltd.

Ekman, P., & Friesen, W.V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology, 17,* 124-129.

Ekman, P., Sorenson, R.E., & Friesen, W.V. (1969). Pan-cultural elements in facial displays of emotion. *Science, 164*, 86-88.

Elfenbein, H.A., & Ambady, N. (2002). Is there an in-group advantage in emotion recognition? *Psychological Bulletin, 21*, 243-249.

Etcoff, N.L., & Magee, J.J. (1992). Categorical perception of facial expressions. *Cognition, 44,* 227-240.

Fantz, R.L. (1958). Pattern vision in young infants. *The Psychological Record, 8*, 43-47.

Farroni, T., Menon, E., Rigato, S., & Johnson, M.H. (2007). The perception of facial expressions in in newborns. *European Journal of Developmental Psychology, 4,* 2-13.

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). London: Sage Publications.

Field, T.M., Woodson, R., Cohen, D., Greenberg, R., Garcia, R., & Collins, K. (1983). Discrimination and imitation of facial expressions by term and preterm neonates. *Infant Behavior and Development, 6*, 485-489.

Field, T.M., Woodson, R., Greenberg, R., & Cohen, D. (1982). Discrimination and imitation of facial expressions by neonates. *Science, 218*, 179-181.

Fiske, S.T., Kitayama, S., Markus, H.R., & Nisbett, R.E. (1998). The cultural matrix of social psychology. In D.T. Gilbert, S.T. Fiske, & G. Lindzey (Eds.), *Handbook of social psychology* (4th ed., Vol. 2, pp. 915–981). New York: McGraw- Hill.

Fox, N. A. (1994). The development of emotion regulation: Biological and behavioral considerations. *Monographs of the Society for Research in Child Development, 59,* (2-3, Serial No. 240).

Fridlund, A.J. (1994). *Human facial expression: An evolutionary view*. New York: Academic Press.

Fridlund, A.J. (1997). The new ethology of human facial expressions. In J.A. Russell, & Fernandez-Dols, J.M. (Eds.), *The psychology of facial expression* (pp. 57-77). United Kingdom: Cambridge University Press.

Harris, L., Atkinson, J., & Moar, K. (1977). Development of contrast sensitivity over the first three months of life in the human infant. *Vision Research, 17*, 1037-1044.

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

Hess, U., & Thibault, P. (2009). Darwin and emotion expression. *American Psychologist, 64,* 120-128.

Hoehl, S., & Striano, T. (2008). Neural processing of eye gaze and threat-related emotional facial expressions in infancy. *Child Development, 79*, 1752-1760.

Hoehl, S., & Striano, T. (2010). The development of emotional face and eye gaze processing. *Developmental Science, 13*, 813-825.

Horrowitz, F.D.E. (1974). Visual attention, auditory stimulation, and language discrimination in young infants. *Monographs of the Society for Research in Child Development, 39*, 5-6.

Horstmann, G. (2002). Facial expressions of emotion: Does the prototype represent central tendency, frequency of instantiation, or an ideal? *Emotion, 2*, 297-305.

Horstmann, G. (2003). What do facial expressions convey: Feeling states, behavioral intentions, or action requests. *Emotion, 3,* 150-166.

Izard, C.E. (1971). *The face of emotion*. New York: Meredith Corporation.

Izard, C.E. (1977). Emotions and facial expressions: A perspective from differential emotions theory. In J.A. Russell, & Fernandez-Dols, J.M. (Eds.), *The psychology of facial expression* (pp. 57-77). United Kingdom: Cambridge University Press.

Izard, C. E., & Malatesta, C. Z. (1987). Perspectives on emotional development I: Differential emotions theory of early emotional development. In J. D. Osofsky (Ed.), *Handbook of infant development* (2nd ed., pp. 494-554). New York: Wiley-Interscience.

Jeon, H., Moulson, M.C., Fox, N., Zeanah, C., & Nelson, C.A. (2010). The effects of early institutionalization on the discrimination of facial expressions of emotion in young children. *Infancy, 15,* 209-221.

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.

Kestenbaum, R., & Nelson, C.A. (1990). The recognition and categorization of upright and inverted emotional expressions by 7-month-old infants. *Infant Behavior and Development, 13*, 497-511.

Klineberg, O. (1940). *Social psychology*. New York: Holt.

Kotsoni, E., de Haan, M., & Johnson, M.H. (2001). Categorical perception of facial expressions by 7-month-old infants. *Perception, 30*, 1115-1125.

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.

Laible, D.J., & Thompson, R.A. (1998). Attachment and emotional understanding in preschool children. *Developmental Psychology, 34*, 1038-1045.

Leppanen, J.M., Moulson, M.C., Vogel-Farley, V.K., & Nelson, C.A. (1999). An ERP study of emotional face processing in the adult and infant brain. *Child Development, 78*, 232-245.

Leppanen, J.M., & Nelson, C.A. (2009). Tuning the developing brain to social signals of emotions. *Nature Reviews Neuroscience, 10*, 37-47.

Leppanen, J.M., & Nelson, C.A. (2012). Early development of fear processing. *Current Directions in Psychological Science, 21,* 200-204.

LoBue, V., & DeLoache, J.S. (2010). Superior detection of threat-relevant stimuli in infancy. *Developmental Science, 13,* 221-228.

Ludemann, P.M. (1991). Generalized discrimination of positive facial expressions by seven-and ten month-old infants. *Child Development, 62*, 55-67.

Ludemann, P.M., & Nelson, C.A. (1988). Categorical representation of facial expressions by 7-month-old infants. *Developmental Psychology, 24*, 492-501.

Lyons-Ruth, K., Connell, D.B., Zoll, D., & Stahl, J. (1987). Infants at social risk: Relations among infant maltreatment, maternal behavior, and infant attachment behavior. *Developmental Psychology, 23*, 223-232.

Mangelsdorf, S.C. (1992). Developmental changes in infant-stranger interaction. *Infant Behavior and Development, 15,* 191-208.

Matas, L., Arend, R.A., & Sroufe, A. (1978). Continuity of adaptation in the second year: The relationship between quality of attachment and later competence. *Child Development, 49*, 547-556.

Matsumoto, D. (1991). Cultural influences on facial expression of emotion. *Southern Communication Journal, 56,* 128-137.

Matsumoto, D., & Ekman, P. (1989). American-Japanese cultural differences in intensity ratings of facial expressions of emotion. *Motivation and Emotion, 13*, 143-157.

Maurer, D., & Salapatek, P. (1976). Developmental changes in the scanning of faces by young infants. *Child Development, 47*, 523-527.

Mervis, C.B., & Rosch, E. (1981). Categorization of natural objects. *Annual Review of Psychology, 32*, 89-115.

Montague, D. P. F., & Walker-Andrews, A. S. (2002). Mothers, fathers, and infants: The role of person familiarity and parental involvement in infants' perception of emotion expressions. *Child Development, 73,* 1339-1352

Moulson, M.C., Fox, N.A., Zeanah, C.H., Nelson, C.A. (2009). Early adverse experiences and the neurobiology of facial emotion processing. *Developmental Psychology, 45*, 17-30.

Mumme, D.L., Fernald, A., & Herrera, C. (1996). Infants' responses to facial and vocal emotional signal in a social referencing paradigm. *Child Development, 67*, 3219-3237.

Nelson, C.A. (1987). The recognition of facial expressions in the first two years of life: Mechanisms of development. *Child Development, 58*, 889-909

Nelson, C. A., & Dolgin, K. G. (1985). The generalized discrimination of facial expressions by seven-month-old infants. *Child Development, 56,* 58-61.

Nelson, C. A., Morse, P.A., & Leavitt, L. A. (1979). Recognition of facial expressions by seven-month-old infants. *Child Development, 50,* 1239-1242.

Oster, H. (2005). The repertoire of infant facial expressions: an ontogenetic perspective. In J. Nadel, & D. Muir (Eds.), *Emotional development* (pp. 261-292). New York: Oxford University Press.

Peltola, M.J., Leppanen, J.M., & Hietanen, J.K. (2011). Enhanced cardiac and attentional responding to fearful faces in 7-month-old infants. *Psychophysiology, 48,* 1291-1298.

Peltola, M.J., Leppanen, J.M., Maki, S. & Hietanen, J.K. (2009). Emergence of enhanced attention to fearful faces between 5 and 7 months of age. *Social Cognitive and Affective Neuroscience, 4,* 134-142.

Peltola, M.J., Leppanen, J.M., Palokangas, T., & Hietanen, J.K. (2008). Fearful faces modulate looking duration and attention disengagement in 7-month-old infants. *Developmental Science, 11*, 60-68.

Podsakoff, P.M., Mackenzie, S.B., Lee, J.Y., Podsakoff, N.P. (2003). Common method bias in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*, 879-903.

Pollak, S. D., Cicchetti, D., Hornung, K., & Reed, A. (2000). Recognizing emotion in faces: Developmental effects of child abuse and neglect. *Developmental Psychology, 36,* 679–688.

Pollak, S.D., & Kistler, D.J. (2002). Early experience is associated with the development of categorical representations for facial expressions of emotion. *PNAS, 99,* 9072-9076.

Pollak, S.D., & Messner, M., Kistler, D.J., Cohn, J.F. (2009). Development of perceptual expertise in emotion recognition. *Cognition, 110,* 242-247.

Pollak, S.D., & Sinha, P. (2002). Effects of early experience on children's recognition of facial displays of emotion. *Developmental Psychology, 38*, 784-791.

Quinn, P.C. & Tanaka, J.W. (2007). Early development of perceptual expertise: Within-basic-level categorization experience facilitates the formation of subordinate-level category representations in 6-to 7-month-old infants. *Memory and Cognition, 35,* 1422-1431.

Roseman, I.J., & Smith, C.A. (2001). Appraisal theory. In K.R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion* (pp. 3-19). New York: Oxford University Press.

Russell, J.A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39,* 1161-1178.

Russell, J.A. (1994). Is there universal recognition of emotion from facial expressions? A review of the cross-cultural studies. *Psychological Bulletin, 115,* 102-141.

Schaffer, H.R. (1966). The onset of fear of strangers and the incongruity hypothesis. *Journal of Child Psychology and Psychiatry, 7,* 95-106.

Scherer, K.R. (1992). What does facial expression express? In K.T. Strongman (Ed.), *International review of studies on emotion* (Vol. 2., pp. 139-166), England: British Library Cataloguing in Publication Data.

Schlosberg, H. (1952). The description of facial expressions in terms of two dimensions. *Journal of Experimental Psychology, 44,* 229-237.

Schlosberg, H. (1954). Three dimensions of emotion. *Psychological Review, 61*, 81-88.

Schwarzer, G., Zauner, N., & Jovanovic, B. (2007). Evidence of a shift from featural to configural face processing in infancy. *Developmental Science, 10,* 452-463.

Steele, H., Steele, M., Croft C., & Fonagy, P. (1999). Infant-mother attachment at one year predicts children's understanding of mixed emotions at six years. *Social Development, 8,* 161-178.

Steele, H., Steele, M., & Croft, C. (2008). Early attachment predicts emotion recognition at 6 and 11 years old. *Attachment and Human Development, 10*, 379-393.

Striano, T., & Rochat, P. (2000). Emergence of selective social referencing in infancy. *Infancy, 1,* 253-264.

Sullivan, R.M., & Holman, P.J. (2010). Transitions in sensitive period attachment learning in infancy: The role of corticosterone. *Neuroscience and Biobehavioral Reviews, 34*, 835-844.

Tinbergen, N. (1952). "Derived" activities: Their causation, biological significance, origin, and emancipation during evolution. *The Quarterly Review of Biology, 27*, 1, 1-26.

Tottenham, N., Tanaka, J.W., Leon, A.C., McCarry, T., Nurse, M., Hare, T.A., Marcus, D.J., Westerlund, A., Casey, B., & Nelson, C. (2009). The NimStim set of facial expressions: Judgments from untrained research participants, *Psychiatry Research*, *168*, 242-249.

Vaish, A., Grossmann, T., & Woodward, A. (2008). Not all emotions are created equal: The negativity bias in social-emotional development. *Psychological Bulletin*, 134, 383-403.

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., & Organ, T.A. (1988). The development of social referencing. *Child Development, 59*, 1230-1240.

Walker-Andrews, A. S. (1997). Infants' perception of expressive behaviors: Differentiation of multimodal information. *Psychological Bulletin, 121,* 437-456.

Walker-Andrews, A. S., & Dickson, L. R. (1997). Infants understanding of affect. In S. Hala (Ed.), *The development of Social Cognition* (pp. 161-183). United Kingdom: British Library Cataloguing in Publication Data.

Walker-Andrews, A.S., Krogh-Jespersen, S., Mayhew, E.M.Y., & Coffield, C.N. (2011). Young infants' generalization of emotional expression: Effects of familiarity. *Emotion, 11*, 842-851.

Weeks, J. S., & Hobson, P. R. (1987). The salience of facial expression for autistic children. *Journal of Child Psychology and Psychiatry, 28,* 137-152.

Wismer Fries, A.B., Pollak, S.D. (2004). Emotion understanding in postinstitutionalized eastern European children. *Development and Psychopathology, 16,* 355-369.

Wolff, P.H. (1963). Observations on the early development of smiling. In B.M. Foss (Ed.), *Determinants of infant behavior*. (pp. 113-134). New York: John Wiley.

Woodsworth, R.S. (1938). *Experimental psychology*. New York: Holt.

Young-Browne, G., Rosenfeld, H.M., & Horowitz, F.D. (1977). Infant discrimination of facial expressions. *Child Development, 48,* 555-562.

Young, A.W., Rowland, D., Calder, A.J., Etcoff, N.L., Seth, A., & Perrett, D.I. (1997). Facial expression megamix: Tests of dimensional and category accounts of emotion recognition. *Cognition, 63,* 271-313.

Zeanah, C.H., Smyke, A.T., Koga, S.F., & Carlson, E. (2005). Attachment in institutionalized and community children in Romania. *Child Development, 76*, 1015-1028.