ABSTRACT

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Emotions are conveyed largely through facial expressions and prosody. One important part of language development is learning to express and comprehend these features of emotion. This study examined infants' ability to pair facial expressions with corresponding prosody for "happiness" and "fear". These emotions differ in valence but contain similar prosody. Sixteen-month-olds viewed a single video screen displaying either a happy or fearful facial expression. Simultaneously they heard a series of phrases containing either fearful or happy intonation. During some trials the voice and face expressed the same emotion; during other trials there was a mismatch. Infants' looking time was measured during each condition; they were expected to look longer when both the face and voice matched in emotion. Sixteen-month-olds did not look significantly longer during any particular condition. This suggests that infants may have a limited understanding of the manifestations of "fear" and "happiness" at 16 months of age.

EMOTION & PROSODY: EXAMINING INFANTS' ABILITY TO MATCH
SUBTLE PROSODIC VARIATION WITH CORRESPONDING FACIAL
EXPRESSIONS

By

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Chapter 1: Introduction

Human communication involves both verbal cues (language) and non-verbal cues, such as gestures and facial expressions. One domain where these cues can be important is in expressing information about one's emotional state. Children and adults rely on these two forms of communication to express their own feelings and to interpret the emotions of others. Nonverbal cues can be particularly important in conveying emotional information. Emotions can be conveyed visually through the use of facial expressions as well as vocally through the use of prosody (Ekman, Friesen, & Ellsworth, 1972). Often, emotional messages are presented using both of these forms of communication at the same time.

For young infants, learning to interpret and express emotional information are important developing skills. A give and take of various expressions of emotion between mother and child is important for normal development and attachment (Lester, 1992). Failure to establish such a bond between mother and child has been shown to have consequences for the social and emotional development of the individual (Bowlby, 1969). It is therefore important that parents and infants engage in an exchange of emotions for healthy development.

Facial expressions have been suggested to play a key role in developing the mother-infant relationship (Darwin, 1877). In addition, it has been suggested by Fernald (1992) that a mother's use of infant-directed speech allows her infant to come to understand the emotions of others. Infant-directed speech contains particular pitch and prosody that carries affective information as well as serves to gain infants'

attention (Fernald, 1992). Therefore, learning to interpret both the visual and auditory expressions of emotion can be considered an important step in understanding emotion.

Another important step in social development is learning to generalize rules for exchanging emotional information. Infants first learn to interpret the facial expressions and prosody displayed by their own caregivers (Kahana-Kalman & Walker-Andrews, 2001). They must then expand their knowledge to include the emotional expressions of other individuals. Infants must learn to generalize beyond the particular prosody and facial expressions displayed by their own mother, to those displayed by other adults. This generalization leads to an important step in social development – the development of a concept of each emotion.

Little is known about how this concept of emotion develops. Researchers have begun examining when infants develop the ability to pair facial expressions with the corresponding vocal prosody, because the ability to do so suggests that infants have developed an understanding of these aspects of particular emotions. Unlike discrimination tasks, which require infants to recognize differences between emotions, matching tasks test infants' understanding of the vocal and visual manifestations of emotion.   Infants need to understand which facial expressions correspond in emotion to the type of prosody they are hearing in order to match face and voice; they cannot succeed at the task simply by picking up on differences between stimuli. Infants' ability to match auditory and visual expressions of emotion therefore demonstrates the development of a concept of each emotion.

Despite the notion that matching facial expressions and prosody is a critical test of infants' understanding of emotion, much of the initial work investigating emotional development has focused on a more basic skill: the ability to recognize differences between various emotions (Caron, Caron, & MacLean, 1988; Caron, Caron, & Myers, 1982; Field, Woodson, Greenberg, & Cohen, 1982; Ludemann, 1991; Nelson, Morse, & Leavitt, 1979; Schwartz, Izard, & Ansul, 1985; Walker-Andrews & Grolnick, 1983; Walker-Andrews & Lennon, 1991). Discrimination tasks (Caron et al., 1988; Caron et al., 1982; Field et al., 1982; Flom & Bahrick, 2007; Ludemann, 1991; Nelson et al., 1979; Schwartz et al., 1985; Walker-Andrews & Grolnick, 1983; Walker-Andrews & Lennon, 1991) require less sophisticated knowledge of emotion than matching tasks to complete and provide some insight into infants' early recognition of emotions. The ability to discriminate between emotions likely precedes the ability to pair visual and auditory aspects of emotion. Therefore, the age at which infants begin to show the ability to discriminate between emotions sets a lower bound for the age at which they would be expected to pair auditory and visual representations of the same emotions.

Differentiating Between Facial Expressions

The ability to discriminate among different emotions has been examined in infants as young as 2 days of age. Field, Woodson, Greenberg, and Cohen (1982) studied neonates' ability to distinguish between "happy", "sad", and "surprised" facial expressions when presented with a habituation task. In this study neonates were held by an adult model who displayed a series of three facial expressions: "happy", "sad", and "surprised". An observer stood behind the model to judge the

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infant's behavior. After the model gained the infant's attention she presented one of

the expressions and held it until the infant turned away. This process was continued

until infants habituated to the facial expression (i.e. looking time decreased to less

than 2 seconds). At this point the model presented a new facial expression. Infants

were expected to show an increase in looking time following presentation of the new

facial expression. In a habituation task, an increase in looking time would indicate

that the infant noticed the change, and thus was able to discriminate between the

stimuli presented. Field et al. (1982) found that infants looked longer following

changes in expression, indicating that they were able to discriminate between the

facial expressions. A potential confound is that the infants may have been cued by

the model. Since the model was holding the infants he or she could have biased them

to attend longer following his or her change in expression. He or she may have

signaled the infant by moving other body parts in addition to his or her face, as is

natural to do when changing facial expressions. Therefore, it is impossible to

determine whether or not infants in this study were truly responding to changes in

facial expression or were picking up on other signals passed on by the model. In

addition, there is evidence to suggest that prior to approximately 4 months of age,

infants' visual systems are not sufficiently developed to recognize the information in

a face that would convey expression (Nelson, 1987). Even if infants were responding

solely to the facial expression rather than to the other body movements, this would

not indicate that the infants had necessarily assigned any meaning to the expressions.

They may have simply distinguished them based on certain changing features such as

movement of the eyes or lips. Infants may have been able to complete the task by

relying solely on changes in movement of a single feature, rather than on an understanding of the emotions presented.

Studies of older infants provide stronger evidence of the ability to discriminate among the emotions shown by facial expressions. Caron et al. (1982) examined the ability of 4.5-month-olds, 6-month-olds, and 7.5-month-olds to discriminate between "happy" and "surprised" expressions. This task is considerably more difficult as it contains two positive expressions. Infants were habituated to either a "happy" expression or a "surprised" expression and then presented with the other, novel facial expression. The facial expressions used were photographs of unfamiliar mothers displaying each of the two emotions. Results showed that while this task was beyond the ability of the youngest age group, 6-month-olds could succeed. However, this success only occurred when the infants were presented with the "happy" expression as the habituating stimulus, and not vice versa. Caron et al. (1982) suggest that infants' ability to discriminate among positive facial expressions is still emerging at 6 months of age. They interpret this unidirectional finding as a reflection of infants' limited understanding of emotion at this age. Another explanation is that infants notice when others become something other than "happy", but do not notice other changes in emotion.

In a similar study of negative facial expressions, Schwartz, Izard, and Ansul (1985) found that 5 month olds were able to discriminate between photographs of anger, fear, and sadness only when sadness or fear was used as the novel stimulus. These results are consistent with the work of Caron et al. (1982) in that the habituating stimulus again played a role in infants' ability to discriminate between

emotions. In an attempt to explain these results, Schwartz et al. (1985) performed a second experiment using the same methods, but this time included both positive and negative emotions. In this study, 5-month-olds were unable to discriminate between facial expressions of "joy", "anger", and "interest", regardless of which emotion was used as the habituating stimulus. The inconsistent results of these studies, despite the use of comparable stimuli and methods, suggest that infants between 5 and 6 months of age are still developing the skills necessary to discriminate among various emotions. Prior to learning to discriminate between emotions, infants are unlikely to have developed a concept of each emotion. Therefore, it can be concluded that infants between 5 and 6 months of age are unlikely to have formed a concept of each emotion.

Results from studies of older infants demonstrate increased ability to differentiate between similar emotions. Caron et al. (1982) found 7-month-olds to be reliable in discriminating between the two expressions of "surprise" and "happiness", regardless of which expression was seen first. In contrast, Nelson, Morse, and Leavitt (1979) found that 7-month-olds can discriminate between "happy" and "fearful" faces only if first habituated to "happy" expressions, and not if first habituated to "fear". This study was similar to that of Caron et al. (1982) in that photographs of females were used as stimuli and that various faces belonging to different individuals were used during both familiarization and test trials. Despite these similarities, the conflicting findings suggest that the ability to discriminate among facial expressions is improving by 7 months of age, but may be limited to particular expressions.

All of the previous studies of infants' ability to discriminate between facial expressions have used still photographs as stimuli. However, previous research has suggested that infants have difficulty recognizing emotion in photographs (Caron, Caron, & Myers, 1985). Therefore, it is unknown whether these results would generalize to similar studies involving video representations of emotion. It is possible that the static nature of pictures might highlight different aspects of the expression than would be apparent during dynamic representations where facial features are moving and changing.

Differentiating Between Prosodic Cues to Emotional State

Emotional expression is not only displayed on the face, but is also found in the voice, particularly in prosodic cues. Infants rely on prosodic cues in order to differentiate between various types of stimuli at an early age. As early as 2 months of age, American infants have been found to differentiate between utterances in their native language and those in foreign languages by relying on prosodic cues (Mehler, Jusczyk, Lambertz, Halsted, Bertoncini, & Amiel-Tison, 1988). In addition, 9-month-old infants have been found to show a preference for prosodic cues common to their native language (Jusczyk, Cutler, & Redanz, 1993). Jusczyk et al. (1993) found that American infants show a preference for the predominant stress patterns found in English words. Furthermore, research suggests that infants may use this knowledge of the predominant stress pattern in order to assist in segmentation at an early age (Jusczyk et al., 1993). In all of these studies of infants' early understanding of prosodic cues (Mehler et al., 1988; Jusczyk et al., 1993) linguistic content was filtered in order to demonstrate that infants were truly relying on prosodic cues in completing

each task. Taken together, this research suggests that infants attend to prosodic cues from a very young age (i.e. 2-months) and continue to use this information during infancy to differentiate between their native language and other languages and to assist in language development.

In addition to studies examining discrimination of prosodic cues which serve a linguistic function, some studies have explored infants' ability to discriminate between prosodic expressions of emotion (Walker-Andrews & Grolnick, 1983; Walker-Andrews & Lennon, 1991). These studies focus on infants' ability to differentiate between emotions when presented with vocal expressions of various emotions.

By 5 months of age, infants have been found to discriminate vocal expressions of "happy" and "sad" emotions, while 3-month-olds show more variable results (Walker-Andrews & Grolnick, 1983). In this study infants were habituated to either "happy" or "sad" vocal expressions and then presented with exemplars of either the opposite vocal expression or the same vocal expression. All vocal expressions were recorded using the same talker. Five-month-olds decreased looking time when presented with exemplars of the same vocal expression and increased looking time when presented with items containing the opposing vocal expression, showing success at the task. 3-month-olds, however, only succeeded at the task when first habituated to "sad" vocal expressions, and not when initially presented with "happy" vocal expressions. These results suggest that by 5 months of age infants are able to perform basic discrimination tasks involving prosody of one positive and one negative emotion.

Discrimination of Bimodal Presentations of Emotion

In addition to discrimination tasks involving facial expressions in isolation, several discrimination tasks focus on differentiation of bimodal representations of emotion (Caron, Caron, & MacLean, 1988; Flom & Bahrick, 2007; Walker-Andrews & Lennon, 1991). These studies focus on infants' ability to differentiate between emotions when provided with both visual and auditory information. When facial expressions are presented in conjunction with emotional prosody, performance on discrimination tasks improves, and infants as young as 4-5 months of age have been found to reliably discriminate among different bimodal expressions of emotion (Caron, Caron, & MacLean, 1988; Walker-Andrews & Lennon, 1991).

In a set of five experiments with 4, 5, and 7-month-old infants, Caron et al. (1988) examined the effect of bimodal stimuli on infants' ability to discriminate between emotions. Videos of several women reading a script using either "happy", "angry", or "sad" prosody were used as stimuli. These women displayed emotional facial expressions while reading the script or for some trials remained silent. In all conditions where face and voice were presented simultaneously to the infants, the stimuli shared the same affect. That is, if the voice sounded "happy" then the facial expression was also "happy". Through a series of habituation tasks, Caron et al. (1988) found that 4-month-olds could discriminate between bimodal representations of "happy" and "sad", but only when the "sad" video was used as the habituating stimulus. Five-month-old infants were found to differentiate between bimodal representations of "happy" and "sad" regardless of which video was shown first, but could not differentiate between bimodal representations of "happy" and "angry".

Seven-month-olds were found to differentiate between "happy" and "angry", but only when videos were accompanied by vocal expressions of emotion and not when they were presented in silence. In all of these habituation tasks (Caron et al., 1988), a single representation of each emotion was used, rather than multiple examples of each emotion. It is therefore possible that infants habituated to specifics of the token and would likely dishabituate when presented with any type of differing stimuli, regardless of the emotion it contained. Therefore, it is unclear whether infants in this study were habituating to the emotion presented or to other aspects of the video.

The idea that infants are able to differentiate between emotional stimuli at an earlier age when it is presented in multiple modalities is further supported by recent research done by Flom and Bahrick (2007). In an infant-controlled habituation study of 4, 5, and 7-month-old infants Flom and Bahrick (2007) found that all ages were capable of differentiating between "happy", "angry", and "sad" when presented with video of a female displaying a dynamic facial expression while simultaneously using emotional prosody. Flom and Bahrick (2007) also studied infants' ability to discriminate between emotions when presented with unimodal versus bimodal stimuli. When presented with bimodal stimuli infants were able to discriminate between a wider variety of emotions than when presented with stimuli in a single modality (Flom & Bahrick, 2007). This result is similar to the findings of Caron et al. (1988) in that bimodal presentation of emotion facilitated infants' ability to discriminate between emotions. While Caron et al. (1988) and Flom and Bahrick (2007) both used video stimuli and similar methods, their results differ in that Flom and Bahrick (2007) found infants to discriminate between bimodal representations of

"happy" and "angry" at a younger age (i.e. 4 months of age rather than 7 months of age). The difference in auditory stimuli between the two studies may help to explain this discrepancy. While both Caron et al. (1988) and Flom and Bahrick (2007) used a female voice reciting a script, the phrases used by Flom and Bahrick (2007) contained semantic information (i.e. the words "happy" and "beautiful") that conflicted with two of the emotions being portrayed (i.e. anger and sadness). Despite this confound, the work of Flom and Bahrick (2007) supports Caron et al.'s (1988) finding that young infants are able to discriminate bimodal expressions of emotion more readily than unimodal depictions. Furthermore, Flom and Bahrick (2007) extended these findings to conclude that the ability to discriminate emotion progresses from differentiation of bimodal representations, to differentiation of auditory stimuli alone and finally to discrimination of videos in isolation. By 7 months of age, Flom and Bahrick (2007) found infants to be capable of succeeding at all types of discrimination tasks (i.e. bimodal, unimodal auditory, and unimodal visual) for the emotions of "happiness", "sadness", and "anger". Overall, the results of these experiments suggest that infants are able to succeed at discrimination tasks at a younger age when they are provided with stimuli containing both auditory and visual emotional information.

There are several possible explanations for infants' improved performance with bimodal stimuli. One possibility is that the presence of stimuli in multiple modalities is more appealing to infants, and therefore they were more attentive during these tasks. Another possibility is that infants learn to interpret emotional information in context. Infants may be focusing on both prosodic and visual cues in

their perception of emotion. Rather than interpreting the information piece by piece, it is possible that young infants combine cues from prosody and facial expression to form a concept of each emotion. Walker-Andrews and Lennon (1991) examined these possibilities and questioned whether or not the presence of any type of visual stimuli, whether it contained emotional information or not, would help infants succeed at a habituation task. To explore this, Walker-Andrews and Lennon (1991) tested 5-month-old infants' ability to discriminate between prosodic representations of "happiness", "anger", and "sadness". In this study infants viewed either a picture of a facial expression or a checkerboard pattern while listening to vocal expressions of emotion. Walker-Andrews and Lennon (1991) found that 5-month-old infants were able to succeed at the task only when a facial expression accompanied the habituation task, and not when presented with a checkerboard pattern. Moreover, they found that infants were able to succeed at the task regardless of whether or not the facial expression matched the prosody in affect. These results suggest that young infants are better at discriminating among emotional prosody when it is presented in context with an accompanying facial expression (Walker-Andrews and Lennon, 1991).

It is important to note that studies involving bimodal representations of emotion differ from matching tasks. Bimodal tasks involve presentation of a single event in multiple modalities. Matching tasks differ in that the stimuli are presented as separate events which do not co-occur. The audio and visual stimuli in a matching task would correspond only in affect and would be absent of any additional factors linking face and voice. More specifically, the facial expressions presented in a

matching task would be presented without mouth movements corresponding to the auditory stimuli in order to prevent infants from interpreting stimuli as corresponding to a single event. A matching task therefore can be considered more complex than a bimodal discrimination task in that infants are presented with multiple events and are asked to pair them based solely on similarities in affect.

Role of Familiarity

Infants' early ability to discriminate among facial expressions appears to depend on both context and familiarity. Kahana-Kalman and Walker-Andrews (2001) found that 3.5-month-old infants were successful at matching facial and vocal expressions for "happiness" and "sadness" only when the stimuli were from their own mothers and not when presented with the same emotions being portrayed by an unfamiliar female. In addition, only when infants reach 10 months of age can they look beyond individual changes in the face in order to generalize between and categorize expressions. Ludemann (1991) found that while 7-month-olds focus on specific features of the face related to emotion, 10-month-olds are beginning to look beyond individual features and respond to overall affect when presented with positive facial expressions. In this task infants were habituated to models posing a variety of positive facial expressions and tested on their ability to recognize a novel positive expression on the face of a novel model. Ten-month-olds, but not 7-month-olds, were found to discriminate expressions following habituation to a variety of prototypical positive expressions. This suggests that infants begin to categorize the emotions displayed by facial expressions as positive or negative around 10 months of age. In

order to do this, infants must group varying expressions based on similar affect, a task that shows increased ability to generalize emotional information.

Matching Audio and Visual Stimuli

While discrimination tasks give insight into infants' perception of various emotions, they provide little information regarding when infants develop an understanding of each emotion. The ability to pair facial expressions with corresponding prosody is a more complex task that requires a more sophisticated understanding of emotional information. Matching tasks requiring infants to pair visual and auditory information provide greater insight into when infants begin to develop a concept of each emotion. Early studies examining infants' abilities to pair visual and auditory emotional stimuli have focused on comparing positive and negative emotions (i.e. happiness to sadness) or comparing a single emotion to a neutral stimulus (i.e. happiness to a neutral expression). These tasks required infants to match prosody and facial expressions for vastly different emotions such as happiness and sadness, or contained only a single emotion to be compared to stimuli devoid of any emotional expression (Walker, 1982; Soken & Pick, 1992; Lundy, Field, Cigales, Cuadra, and Pickens, 1997).

Walker (1982) found that infants 5 and 7 months of age could detect correspondence between vocal emotional information and facial expressions when presented with a single affective expression. Using a preferential looking paradigm, Walker (1982) presented two videos simultaneously to infants. One video contained an affective expression (i.e. happiness) while the other contained a blank face. Five- and seven-month-old infants were found to show a preference for watching the

"happy" face over the neutral face when hearing "happy" prosody (Walker, 1982).

However, it is unknown whether infants used their knowledge of emotion to complete

this matching task, or if they were relying on synchrony in order to complete the task.

In order to test this, Walker (1982) displayed the same stimuli, this time with a

several second delay between the video and audio track. When the stimuli were

presented out of synchrony, 7-month-olds continued to show a preference for the

video containing the same affect as the audio track. This suggests that infants may be

attending not only to synchrony, but also to affect when pairing visual with audio

stimuli.

In a slightly more complex task, Soken and Pick (1992) examined whether or

not 7-month-olds can use individual facial features to discriminate between "angry"

and "happy" expressions. In this preferential looking study infants viewed two video

screens, one with an actress portraying "happiness", the other with the same actress

portraying "anger". The actress spoke throughout the length of each video but the

audio track was omitted during presentation. At the same time, infants heard a

different woman speaking with either "angry" or "happy" prosody, but using different

semantic content. In one condition both videos were fully illuminated and in another

only portions of each video that were considered relevant for the emotional

expression were illuminated (i.e. the mouth and eye region). The purpose of this was

to see if infants were using motion information related to specific facial features to

aid in discrimination. In other words, the study aimed to determine if infants were

relying on the movement of a specific facial feature (e.g. the eyes) to complete a

discrimination task or were processing the face as a whole. While matching vocal

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and visual stimuli was not the main focus of this study, the results support those found by Walker (1982) and suggest that 7-month-olds can detect a correspondence between the vocal and facial expressions of one positive and one negative emotion.

Stronger evidence of infants' ability to pair auditory and visual emotional information can be found in a study by Lundy et al. (1997). In this study, 10-month-old infants of mothers with depressive symptoms participated in a preferential looking task along with a control group of same-age infants whose mothers had not reported symptoms of depression (Lundy et al., 1997). Infants viewed prototypical expressions of happiness and sadness displayed by an unfamiliar woman, while at the same time hearing prosody corresponding to one of the two emotions. Results showed that infants in the control group were successful at the task for both "happy" and "sad" expressions, while infants of depressive mothers were less successful in matching "happy" facial expressions with the corresponding vocal expression. Infants of depressed mothers looked randomly between "happy" and "sad" expressions. These results show that infants of mothers who are not depressed are likely to have formed a concept of "happy" and "sad" by 10-months of age. In addition, the results from infants of depressed mothers suggest that the ability to pair visual and auditory aspects of emotion is likely to be related to individual experience with particular emotions.

Pilot A: Matching Visual and Vocal Aspects of Happiness and Surprise

Less is known about whether these findings extend to situations where more subtle matching of a particular emotion with the appropriate face is required.

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Previous matching tasks could be completed simply by pairing the valence of the affect (e.g. positive prosody with the positive face and negative prosody with the negative face). In pilot work, infants' ability to perform a more subtle matching task involving two similar emotions ("surprise" and "happiness") was examined. Rather than simply looking at discrimination, this work looked at infants' ability to correctly associate two similar emotional facial expressions with corresponding prosody. It was presumed that the ability to not only discriminate between expressions and between prosody, but also to match the two, is a more sophisticated ability that shows infants have formed an understanding of the emotional information these cues are intended to convey. Furthermore, unlike previous matching tasks, all of which involved two emotions with different valences and dissimilar facial features and prosody, this study required infants to show an understanding of two closely related emotions whose corresponding facial expressions and prosody are similar. In this task, prosody and facial expressions could not be paired by relying on distinct differences in valence or changing features alone. Rather, this study required infants to have a concept of each particular emotion in order to demonstrate success with the task.

In this study, ten 16-month-old infants viewed two video screens – one with a woman demonstrating a "surprised" facial expression and another with the same woman demonstrating a "happy" facial expression. Figure 1 below is an example of a still frame taken from the moving video that was presented to the participants. The facial expressions were not static; they were presented as moving videos. On each trial infants heard either a series of infant-directed phrases being spoken with

"surprised" prosody or "happy" prosody. Infants' performance was measured using a preferential looking paradigm where successful association of facial expression and prosody was defined as relatively longer looking time to the video that matched the prosody they were hearing. Sixteen-month-olds were found to be unsuccessful at this task when presented with facial expressions that are typically displayed during adult-to-adult interactions.

Adult Directed Facial Expressions

Happy   Surprised

Figure 1. Still frame of Adult-Directed facial expressions used in Pilot Study A.

These findings might suggest that infants at this age still have a limited understanding of emotion. However, an alternative possibility is that the particular facial expressions used were not appropriate for infants. Chong, Werker, Russell, and Carroll (2003) suggest that mothers use unique facial expressions when interacting with their infants, that are significantly different from those used in typical adult-to-adult interactions (see Ekman & Friesen, 1975). For example, the adult-directed facial expression for "surprise" differs in that the sides of the lips are rounded during presentation while the infant-directed expression for "surprise" contains a hint of a smile. In addition, while the infant-directed "happy" expression is

highly similar to that of the adult-directed version, it differs in that the mouth is always slightly open (Chong et al., 2003).

Infants are likely to interact more often with their mothers than other adults, suggesting that they may have less experience with typical adult-directed emotions than with maternal emotional facial expressions. Thus, the use of adult-directed facial expressions in the pilot study may not have been representative of the typical types of emotional information infants are exposed to.

Pilot B: Matching Infant-Directed Representations of Happiness & Surprise

To address this concern, a subsequent study examined infants' performance in the same task when infant-directed facial expressions were used. After reviewing videotaped sessions of adult-infant interactions, two short video clips from a single volunteer were chosen based on their similarity to infant-directed facial expressions as defined in the literature and the ability to separate these facial expressions from any motion related to speech. The facial expression of "surprise" included raised eyebrows (both inner and outer brow) and an open and stretched mouth with slight lip corner pull, consistent with the infant-directed facial expression termed "WOW" by Chong et al. (2003). The expression of "happiness" also followed the parameters for infant-directed facial expressions identified by Chong et al. (2003), specifically for that of the expression termed "JOY" which is defined by wrinkling around the eyes caused by cheek raise and a broad smile. Both expressions were oriented in the center of the screen and contained comparable amounts of movement (see Figure 2 for an example of a still frame from the moving video).

Happy   Surprised

Figure 2. Still frame of Infant-Directed facial expressions used in Pilot Study B.

In this study, twelve 15 ½ -month-old infants viewed two video screens containing infant-directed facial expressions corresponding to the emotions of "surprise" and "happiness". Prior to studying infants, a group of adults completed the task in order to demonstrate that the audio and visual representations of "surprise" and "happiness" were realistic enough to facilitate successful matching of face and voice. On each trial infants heard either a series of infant-directed phrases being spoken with "surprised" prosody or "happy" prosody, or they heard silence. As before, infants' performance was measured using a preferential looking paradigm where successful association of facial expression and prosody was defined as relatively longer looking time to the appropriate match. Despite the change in visual stimuli, infants were again found to be unsuccessful at the task. Fifteen-and- ½-month-olds did not look significantly longer during trials where facial expression and vocal prosody matched than during trials where there was a mismatch. Infants did not show a preference for either matching or mismatching videos, but rather appeared to look randomly between video screens.

Thus, even when presented with the emotional information conveyed by facial expressions familiar to infants, 15 ½ -month-olds continue to show a limited understanding of the visual and vocal expressions of the emotions of surprise and happiness. There are several possible reasons why this might have been the case. One possibility is that the difference in either the prosody or the facial expressions is too subtle for infants to identify. Another possibility is that infants can recognize subtle differences, but their understanding of the emotional information conveyed is limited to whether or not an emotion is positive or negative. Infants may have a

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broad understanding of emotion that involves categorizing emotions by valence. If that is the case, infants would likely view "happiness" and "surprise" as variations of a "positive" expression, rather than as separate emotions. Evidence exists of infants' ability to pair prosody and facial expressions for the emotions of "happiness" and "sadness" (Lundy et al., 1997), which differ in valence. If infants are categorizing emotions as positive or negative, they would be expected to show success with matching tasks involving additional emotions which vary in valence, such as happiness and fear. While "happiness" and "fear" differ in valence, they have a number of similarities in their prosodic characteristics (Banse & Scherer, 1996; Murray & Arnott, 1993; Scherer, 1986), which might make them a more difficult task than pairing "happiness" and "sadness".

A fourth possibility is that the visual and/or prosodic stimuli used in pilot work were not truly representative of the features of "surprise" and "happiness". As stated before, the stimuli used were found by adults to accurately reflect the emotions of "surprise" and "happiness". There is no evidence to suggest that infants would be likely to focus on different aspects of an expression than adults.

Current Study: Matching Visual and Vocal Aspects of Fear and Happiness

The purpose of the present study was to examine infants' ability to match facial expressions to corresponding prosody, using two emotions with subtle variation in prosody – "fear" and "happiness". Although a number of studies have examined infants' discrimination of these facial expressions (Kotsoni, de Haan, & Johnson, 2001; Nelson et al., 1979; Nelson & Dolgin, 1985), the ability to pair them with their

appropriate prosody is likely to require more sophisticated knowledge. Moreover, these two emotions, while very distinct facially, have a number of similarities in terms of prosodic structure. Commonalities in duration, pitch, and speech rate have been established for the prosodic expressions of "fear" and "happiness" (Banse & Scherer, 1996; Murray & Arnott, 1993; Scherer, 1986). Both "happiness" and "fear" are spoken with a faster rate and higher-than-average pitch when compared to neutral expressions (Murray & Arnott, 1993). In addition, a wide pitch range is used during vocal expressions of these two emotions (Murray & Arnott, 1993). "Happiness" and "fear" have many prosodic similarities while previously studied emotions (i.e. "happiness" and "sadness") vary along several dimensions. "Sadness" differs from "happiness" in that a smaller pitch range is used. In addition, "sadness" is expressed using a slower rate of speech than "happiness" (Scherer, 1986).

Infants can succeed at basic matching tasks involving two distinct emotions such as "happiness" and "sadness" (Lundy et al., 1997) but have been unable to complete harder matching tasks involving emotions that are very similar (i.e. "happiness" and "surprise") during pilot work. As a result, it was decided that exploring a middle ground would provide further insight into how emotional understanding develops. The prosodic similarities between vocal expressions of "fear" and "happiness" are likely to make matching these emotions more difficult than pairing "happy" and "sad" expressions, which are very distinct in terms of both facial expression and prosody. On the other hand, this task is likely to be easier than pairing "happy" and "surprised", which are similar in both respects. In addition to serving as a middle ground, the task may provide insight into which particular aspects

of emotion (i.e. prosody, facial features, and/or valence) play a role in infants'

understanding of emotion. Closer examination of these factors will lead to a better

understanding of which features are most salient in infants' concept of emotion at this

age.   While it is possible that infants use valence to perform matching tasks, their

processing of emotional information may be more complex than understanding this

feature alone. Using "fear" and "happiness", which differ in valence but contain

other similarities is useful because it allows us to examine infants' understanding of

other more subtle differences in emotional information.

Examining infants' ability to pair facial expressions with corresponding

prosody in this way will reveal infants' understanding of these manifestations of

"fear" and "happiness". Additionally, when compared with previous work, the results

of this study may give further insight into infants' understanding of emotion. If 16-

month-olds are able to succeed at the current task this would demonstrate that they

are capable of subtle emotion/prosody matching for emotions carrying similar

prosody, but not for emotions with both similar facial and prosodic features. The

ability to pair vocal and visual expressions of emotion may also been seen if infants

in this age group are relying on valence to assist them with subtle emotion/prosody

matching. If infants are grouping emotions by valence, this would also explain their

previous difficulty with earlier tasks involving two positive emotions that could not

be matched by relying on valence alone.

Hypotheses

It was hypothesized that 16-month-old infants would demonstrate the ability

to pair facial and prosodic expressions of "fear" and "happiness". It was expected

that infants would look longer towards facial expression and prosody that matched in affect than towards presentations of facial expression and prosody that contained a mismatch; thus, demonstrating the ability to pair visual and vocal expressions of "fear" and "happiness". These emotions contain different valence, which is expected to make them easier for infants to match than previously tested expressions of "surprise" and "happiness". Infants were expected to show an understanding of the facial and vocal manifestations of "fear" and "happiness" by 16 months of age, as they show an understanding of facial and vocal manifestations of "happiness" and "sadness" at a much earlier age (Lundy et al., 1997).

Chapter 2: Method

Participants

Participants included sixteen 16-month-old typically-developing infants. Volunteers were recruited by calling families in an existing database established by the University of Maryland Infant Studies group. This database contains contact information of parents who have indicated interest in participating in developmental research in the fields of psychology, linguistics, and hearing and speech sciences. Infants whose native language is not English, and/or infants with current cases of otitis media, were excluded from participation. Two infants who failed to complete testing due to fussiness were also excluded.

Infants had an average age of 16 months; 16 days (range: 15;29 – 17;15). Adjusted ages were used for all participants born more than two weeks prior to their expected delivery date. The group consisted of 7 males and 9 females. 68.75% of

participants were classified as Caucasian, 6.25% as Hispanic, and 6.25% as "Other" by parental report. Three participants declined to provide information regarding race.

Stimuli

The visual stimuli consisted of two videos, each of which was presented in isolation. One video displayed the facial expression of fear and the other displayed happiness. Both expressions were obtained by filming female volunteers in front of a white background. Volunteers were asked to act as they would when expressing the positive emotion of happiness, and the negative emotion of fear. After reviewing the videotapes, two short video clips from each of three volunteers were chosen based on their similarity to the standard facial expressions of fear and happiness and the absence of any motion related to speech in the clips. Both expressions chosen were oriented in the center of the screen and contained comparable amounts of movement. Dynamic facial expressions were used because previous research has suggested that infants have difficulty recognizing emotion in static expressions (Caron, Caron, & Myers, 1985) as well as because infants are expected to show increased attention to interactive over still faces (Cohn & Elmore, 1988). Video clips were recorded using a JVC GR-DX77U Digital Video Camera and edited for length using Final Cut Pro, a media-editing system. A group of 10 adults was asked to label each of the six facial expressions, presented in a random order, with a corresponding emotion. The facial expressions labeled most appropriately were chosen. These were labeled "fear/scared" by 70% of the group and "happy/joy" by 80% of the group. Errors were generally to very similar emotions such as "shock" for "fear" and "relief" for

"happiness". The videos chosen both displayed the same actress. Still images of these videos can be seen below (Figure 3).

Visual Stimuli

Happy   Fear

Figure 3. Visual stimuli presented to infants during study.

Two sets of auditory stimuli were also recorded by several female native speakers of English, using a Shure SM51 microphone. Recording took place in a noise-reducing chamber at a 44.1 kHz sampling rate, 16 bits resolution, and items were stored on computer disk. Items consisted of phrases being spoken once with fearful prosody and once with happy prosody. The two sets of speech stimuli (happy and fear) were adjusted to be of the same amplitude and length and contained identical semantic content. The following phrases were used: "Oh, look! Do you see? There it is. Over there! What do you see? Look at that. There it is. Can you see it? Look! That! Do you see that? What is that?". The auditory stimuli for "fear" and "happiness" differed in rate (11.3 second duration for "happy" and 9.7 second duration for "fear") when silent pauses between sentences were removed. The pitch range used was similar for "fear" (166.95 Hz - 527.39 Hz) and "happiness" (173.92 Hz - 528.76 Hz). Auditory tracks were adjusted to match the length of the video tracks (i.e. 20 seconds) by adding silent pauses between phrases.

Prior to beginning the present study, auditory stimuli were presented to adults to confirm sufficient differences between happy versus fearful speech sets. A group of 10 adults were asked to label the emotion being conveyed by each set of auditory stimuli presented in a random order. Survey results were used to select a set of auditory stimuli from a single volunteer. 80% of adults rated the chosen volunteer's expressions as "fear/scared"; errors were to similar emotions such as "distressed" and "very worried". The second set of auditory stimuli from the same volunteer was rated as "happy/excited" by 60% of adults. Errors consisted of similar emotions such as "interested" and "curious"; likely due to one particular phrase in the set, which was identified by listeners to sound

"inquisitive". In order to ensure sufficiency of matching to "happiness" this phrase was re-recorded prior to beginning the study.

As a final test, the combined auditory and visual stimuli were presented to adults in order to confirm sufficiency of matching prior to the start of infant testing. Ten adult volunteers viewed both facial expressions (happiness and fear) presented randomly for 12 trials. During each trial either happy or fearful prosody was played at random. Each volunteer was asked to label the trial as a match (if audio and video conveyed the same emotion) or as a mismatch (if face and voice displayed different emotions). All 10 adults demonstrated accuracy $\geq$ 90% for the matching task; with 9 out of 10 adults demonstrating 100% accuracy. As a result, the stimuli were deemed representative of each emotion and were used for testing with infants.

This process resulted in two separate moving images, one containing a happy facial expression, the other a fearful expression. Auditory stimuli consisted of two tracks, containing fearful and happy prosody respectively. These stimuli were combined to form a video where sometimes the expression on the screen matched the prosody being heard, while at other times the expression and the voice did not match in emotional information (see Figure 4).

PREFERENTIAL LOOKING		**Audio**	
STIMULI		Happy	Fear
Video	Happy	MATCH	MISMATCH
	Fear	MISMATCH	MATCH

Figure 4. Conditions during the preferential looking task.

Procedure

Infant test procedures typically involve presenting either a single video at a time or two videos simultaneously (in a choice procedure). The latter works best when the two videos are approximately equally interesting. When one video is inherently more interesting than the other, this bias can interfere with the ability to perceive effects of matching. Prior research has suggested that infants show a preference for "fearful" expressions over "happiness" (Kotsoni, de Haan, & Johnson, 2001; Nelson & Dolgin, 1985). For this reason, infants viewed only a single video screen displaying a single emotion during each trial. By presenting each emotion separately infants' ability to match expressions could be judged apart from their preference for viewing some emotions over others. Infants were seated on their caregivers' laps in front of a 52" video screen in order to view the visual stimuli. Auditory stimuli were presented through a speaker located at the bottom of the television screen.

Another aspect of infant testing that varies across studies is the use of fixed-length versus infant-controlled trials. Fixed-length trials are of a set length and do not vary based on infants' attention to the stimuli whereas infant-controlled trials can vary in length. When infant-controlled trials are used, the trial continues until the infant is no longer continually attending to the stimuli. In an infant-controlled procedure, once infants' attention to the stimuli decreases to a set amount, the current trial ends and a new trial begins. In order to accommodate a single-video presentation, a fixed length design was chosen over an infant-controlled procedure for the current study. Both fixed-length and infant-controlled designs have been found to yield the same results when studying infants (Haaf, Smith, & Smitley, 1983). Haaf et al. (1983) compared the use of fixed-trial and

infant-control procedures with a group of infants in a preferential looking study of infants' response to face-like patterns. 10-week-old infants were found to display the same performance regardless of whether or not trials were infant-controlled or of a fixed length. Additionally, Haaf et al. (1983) found infants tested using fixed-control trials to be significantly more likely to complete the experiment without fussing or crying than infants tested using an infant-controlled design, which lends further support for choosing fixed-length over infant-controlled trials. Overall, the results of this study support the use of either a fixed length design or an infant-controlled design when studying infants and establish both as equal measures of performance for preferential looking tasks.

A test phase consisted of 14 trials, with each trial lasting 20 seconds. Trial length was based on previous work with infants using a fixed length design (de Haan, Belsky, Reid, Volein, & Johnson, 2004). Each of the trials involved a video stimulus paired with an audio stimulus. These trials occurred in three blocks. During each block, participants were presented with each of four trial types (happy expression + happy prosody, happy expression + fearful prosody, fearful expression + happy prosody, fearful expression + fearful prosody). The remaining two trials consisted of each facial expression + silence, in order to determine a possible preference for one video versus the other. The order of presentation of each trial type was varied across blocks. Infants' looking time towards trials containing matching prosody and facial expression was compared to their looking time towards trials that portray two different emotions to determine infants' ability to pair emotional information. Sixteen-month-olds were expected to look longer towards trials containing matching emotional information, showing an understanding of the emotions presented They were expected to show an understanding of the emotions of fear and

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happiness due to the fact that the facial expressions used contain fewer similarities than previous studies involving "happiness" and "surprise" and they differ in valence. These two factors were predicted to assist infants in pairing facial expressions with prosody. At minimum, infants were expected to show improved performance with this task when compared to previous group performance with the harder task of matching happiness and surprise.

During the test session caregivers were asked to listen to masking music being played over Peltor aviation headphones. This prevented them from being aware of the type of prosody being presented, rendering them unable to differentially influence the infant's behaviors. Experimenters monitored caregivers to ensure that headphones remained on during the course of the session.

Analysis

Each session was digitally videotaped and the experimenter individually coded each participant's looking behaviors following the study. During coding, the experimenter was blind to the condition being presented on each trial. For each trial, infants' total looking time towards the video screen was measured using Supercoder, a program for coding preferential looking on a frame-by-frame basis (Hollich, 2005). The number of frames spent looking was collected and then converted into a total amount of time, in seconds. Statistical analysis consisted of a 2x2 ANOVA with the factors of facial expression and prosody and a paired samples t-test. It was predicted that infants would look significantly longer towards matching trials, demonstrating an understanding of the concepts of fear and happiness.

Chapter 3: Results

In this study, 16-month-old infants viewed a single video screen which successively displayed happy and fearful facial expressions. On each trial infants heard a series of infant-directed phrases being spoken with either fearful prosody or happy prosody.

The average looking times for each trial type are represented in Figure 5. Sixteen-month-olds were found to spend a similar amount of time looking towards the video screen across all conditions. During silent trials, infants looked the facial expression of "fear" for an average of 13.32 seconds and towards "happiness" for an average of 11.83 seconds. Results of a paired samples t-test show no significant difference between looking time towards happy or fearful facial expressions, $t(15)=-1.072$, $p = 0.300$. This suggests that infants did not have a preference for either the "fearful" facial expression or the "happy" facial expression.

Results of a 2 x 2 ANOVA with the main within-subjects factors of facial expression (fear, happiness) and prosody (fear, happiness) revealed no significant main effect of facial expression, $F (3, 12) = 0.196$, $p = 0.665$, and no significant main effect of prosody, $F (3, 12) = 0.781$, $p = 0.391$. There was also no significant interaction between facial expression and prosody, $F (3, 12) = 0.501$, $p=.490$. Combining across conditions, infants did not have significantly longer looking times towards either the matching or mismatching video, $t(15)=-0.629$, $p = 0.539$ (see Figure 6). These findings suggest that 16-month old infants are unable to match the appropriate emotion conveyed by the facial expressions to happy and fearful prosody, as they did not show a significant preference for either matching or mismatching
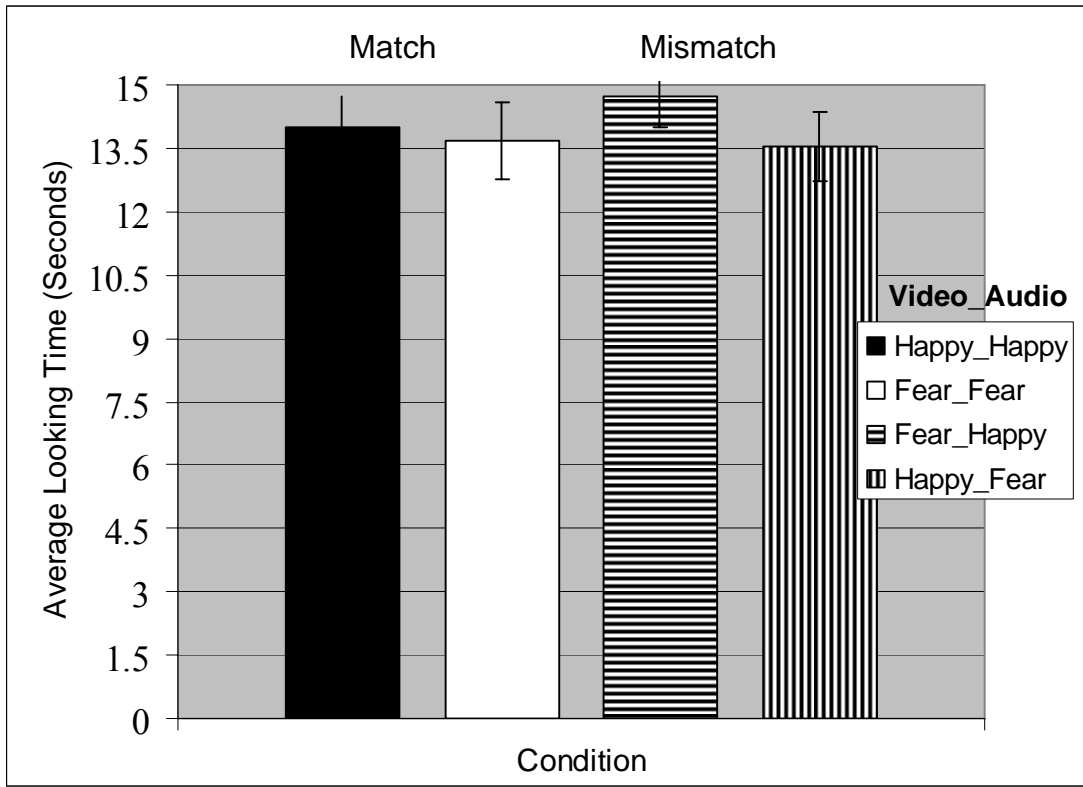
33

trials.

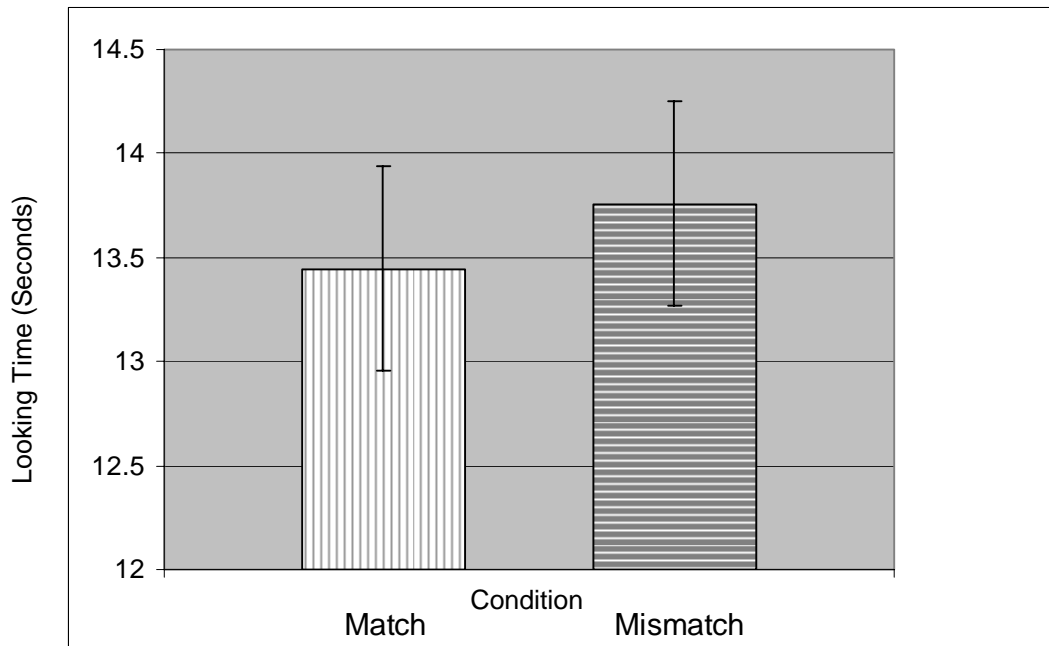*Figure 5.* Average looking time during each condition.

Figure 6. Results of paired samples t-test.

A variety of other analyses were conducted to probe further into this null result. One additional post hoc analysis consisted of a 2x2 ANOVA including only infants who completed all testing blocks. No significant main effect for facial expression, $F_{(3, 9)} = 0.315$, or prosody, $F_{(3, 9)} = 0.343$ was found. There was no significant interaction between facial expression and prosody, $F_{(3, 9)} = 0.622$. Data was then taken from only the first two testing blocks, as infants' looking times were generally longer during the beginning of the study when compared to the last block. A 2x2 ANOVA including only data from the first two testing blocks revealed no significant main effect of facial expression, $F_{(3, 12)} = 0.538$, or prosody, $F_{(3, 12)} = 0.136$. There was no significant interaction between facial expression and prosody, $F_{(3, 12)} = 0.893$. Infants were then divided into three groups based on age. 2x2 ANOVAs were performed for both the oldest age group and the youngest age group. A 2x2 ANOVA of the oldest age group showed no main effect of facial expression or prosody [$F_{(3, 1)} = 0.673$; $F_{(3, 1)} = 0.831$]. There was no significant interaction between facial expression and prosody for the oldest age group, $F_{(3, 1)} = 0.310$. Results from the youngest age group included no significant main effect of facial expression or prosody [$F_{(3, 2)} = 0.290$; $F_{(3, 2)} = 0.909$]. There was no significant interaction between facial expression and prosody in the youngest age group, $F_{(3, 2)} = 0.123$. Again, no significant results or trends were found, suggesting there is no relationship between infants' age at the time of testing and their ability to match manifestations of emotion. Finally, infants were divided into two groups based on gender. A 2x2 ANOVA was performed on each group. No significant main effect of facial expression was found for either group [$F_{(3, 4)} = 0.523$ male group; $F_{(3, 6)} =$

0.580 female group]. There was also no significant main effect of prosody for either the male or female participants [F (3, 4) = 0.890; F (3, 6) = 0.169]. No significant interaction between prosody and facial expression was found for either the male group [F (3, 4) = 0.619] or the female group [F (3, 6) = 0.234].   No significant effects or trends were found, indicating no significant difference between male and female participants' ability to pair facial and vocal expressions of "fear" and "happiness".

Chapter 4: Discussion

This study demonstrated that 16-month old infants do not show a significant preference for matching or mismatching emotional stimuli. In addition, there was no significant interaction between facial expression and prosody. The results of this study do not support the hypothesis that 16-month-old infants would be able to successfully complete a matching task involving the emotions of fear and happiness.

The results of this study suggest that 16-month-olds have a limited understanding of the facial and vocal manifestations of the emotions of fear and happiness. While it was hypothesized that infants would succeed at this task, their difficulty with it provides some insight into their limited understanding of these manifestations of emotion. One conjecture was that infants would find the task easier than previous studies of positive emotions, due to the fact that this study contained emotions of different valences. If infants' early understanding involves organization of emotion into two categories – positive and negative – this would have proved to be an easier task. Sixteen-month-olds' inability to succeed at the task despite the fact that it contains emotions of different valences suggests that their understanding of emotion does not involve categorizing emotions by valence. In fact, differences in valence alone are not enough to aid infants in successfully matching facial expressions with corresponding emotional prosody for the emotions of fear and happiness.

In addition to differing in valence, the emotions of "fear" and "happiness" have other dissimilar aspects. Expressions of "fear" are typically contextual; they are elicited by an external prompt whereas "happiness" can in some situations be

considered a steady state emotion. In other words, expressions of "happiness" are not always brought on by a particular event. Expressions of "fear" on the other hand are more likely to be brought on by an external prompt. Someone can be afraid of something, but is typically not fearful in general. Incorporating these prompts into a study is difficult, but may be an important factor in examining infants' early understanding of vocal and visual expressions of "fear'. "Happiness" further differs from "fear" in that expressions of "happiness" contain changes in acoustic properties that are brought about by the act of producing a "happy" facial expression. The lips retract in order to produce a "happy" facial expression, causing the formants to change. In other words, you can "hear" a smile (Tartter, 1980). Therefore, "happiness" contains changes in acoustic-phonetic properties in addition to changes in prosody, whereas "fear" does not. These nonparallel aspects between "fear" and "happiness" may influence infants' ability to pair vocal and visual aspects of the two emotions.

An additional possibility is that at 16-months of age infants' understanding is limited by their familiarity with particular emotions. While infants are frequently exposed to happy facial expressions and prosody, they are less likely to witness as many examples of fear in their environment. It is possible that these infants' inability to pair audio and visual stimuli stems from their limited understanding of fear. However, given that only two emotions were used in this task, infants could rely on familiarity in and of itself as a factor in completing the task. If infants were able to use their understanding of the single emotion of happiness to help them differentiate between emotions then they would have been able to complete the task by pairing

familiar "happy" audio and visual components. However, infants did not pair happy prosody with happy facial expressions, suggesting that infants are focusing on factors other than familiarity during the matching task.

Fear may not only be less familiar, but may also be less adaptive for infants. Recognizing and attending to expressions of "fear' may not be an important skill for infants. Infants may focus more on "warning" intonation displayed by their caregivers than true prosodic expressions of "fear". When parents display fearful facial expressions they may in fact be more likely to accompany them with warning prosody than fearful prosody. As a result, infants may be more likely to pair warning prosody than fearful prosody with the facial expression of fear.

Another explanation for this finding is that 16-month olds are unable to attach meaning to subtle changes in prosody. The prosodic similarities between expressions of fear and happiness may prevent infants from succeeding at a matching task, despite their potential understanding of facial expressions. While the auditory stimuli used did differ in rate (with "happy" prosody being slower than "fear"), the stimuli utilized a similar pitch range. Infants' early understanding of emotion may be limited by their ability to attach meaning to such subtle variations in prosody. This would help to explain infants' increased ability to pair expressions when presented with "happy" and "sad" prosody which contain differences in both pitch range and rate (Scherer, 1986).

Despite early emergence of the ability to differentiate between a wide range of emotions and previous evidence of infants' ability to pair happy and sad facial expressions with the corresponding prosody, more sophisticated knowledge of these

aspects of emotion appears to develop much later on. In fact, recent research suggests that even at 4 years of age, children still demonstrate a limited understanding of emotion. In a recent study of 2- to 3-year-olds and 4- to 5 year-olds, Widen and Russell (2008) found that the ability to categorize emotion continues to develop throughout the preschool years. Preschoolers participated in two tasks; a free labeling task and a categorization task. In the free labeling task participants were presented with photographs of various expressions and asked to state how the person in the picture was feeling. The expressions were black and white photographs of children displaying the following expressions: happiness, sadness, anger, fear, surprise, and disgust. In the categorization task, infants were presented with a box and told that only people who felt a certain way (i.e. happy, sad, etc.) could go into the box. They were then given various photographs of facial expressions and asked whether or not the face should go in the box or be left out. The following facial expressions were used in the categorization task: surprise, excitement, happiness, contentment, sadness, disgust, anger, and fear.

Widen and Russell (2008) demonstrated that preschoolers begin with a broad understanding of emotion that involves categorizing emotions with similar valence. Preschoolers' included facial expressions with the same valence as the target emotion significantly more often than including facial expressions with the opposing valence during the categorization task. In addition, preschoolers' errors during the labeling task were not random, and were more likely to be emotions of the same valence than those with opposing valence. Their understanding then gradually narrows throughout the preschool years (Widen & Russell, 2008). Preschoolers progressed from using a

single emotion (i.e. happiness) to label facial expressions to using up to six different emotions during the labeling task. In addition, they gradually narrowed the number of facial expressions they included in each box during the categorization task. Furthermore, Widen and Russell (2008) found that differentiation of fear from other negative facial expressions was slower to develop than differentiation of the other emotions. Preschoolers continued to include many facial expressions in this category after other categories had been narrowed and did not use fear accurately as a label until they had mastered "happiness", "sadness", and "anger". This suggests that the concept of fear develops later than happiness, sadness, and anger. Given this, future studies involving "fear" should focus on older age groups. Taken together, these findings suggest that understanding of emotion is a complex process that continues into the preschool years and supports the possibility that infants are not yet able to pair subtle changes in emotion and prosody by 16-months of age.

Future Research

Further research using the same methods with older infants may help to substantiate the current findings. If older infants are able to succeed at the same task, it can be concluded that 16-month-old infants do not yet understand the visual and vocal manifestations of the emotions of "fear" and "happiness" rather than their failure being the result of difficulty with the stimuli or aspects of the task itself. Studying older infants and/or children using the same paradigm may present some difficulties. Children may not find the video interesting enough to attend for an extended period of time, which would limit the extent to which older ages could be tested. However, the preferential looking paradigm has been successfully used to test

children as old as 3 years of age (Swensen, Kelley, Fein, & Naigles, 2007),

suggesting that given appropriate stimuli, it could be successfully used in testing

older age groups. On the other hand, replicating the current study may continue to

prove unsuccessful due to the fact that preferential looking tasks themselves may not

be sensitive enough to detect infants' understanding of emotion. Despite the success

of the preferential looking paradigm in studying other aspects of language

development, it has not yet been frequently used to study understanding of emotion.

For this reason, research using alternative paradigms may also be beneficial. For

example, infants' ability to use emotional information from their caregiver to respond

to a contrived situation appropriately may provide different information. Infants may

demonstrate a stronger understanding of emotion when presented with situations

common to their daily life which would require the use of such information. An

example of such a situation would be responding to a caregiver's expression of "fear"

by avoiding an object or an expression of "surprise" by following the caregivers' gaze

towards the object eliciting this reaction.

Additional information may be obtained by studies which focus on infants'

reactions during a matching task. A systematic analysis of infants' own facial

expressions during this task may provide further information regarding infants'

understanding. Throughout the current study, infants responded to the stimuli not

only by looking towards the screen, by also by making facial expressions of their

own. These reactions may provide insight into which aspects of emotion infants

found to be most salient during the task. Analyzing these responses to determine

whether infants' reactions most closely matched the prosody being heard, the facial

expression presented, or neither on each trial may show trends towards an understanding of one of these features of emotion. Results of such a study would help to determine whether or not infants are displaying a generalized misunderstanding of the emotions presented or they are focusing on a single component (i.e. prosody or facial expression) when responding to the stimuli.

Research using the emotional expressions of infants' own caregivers as stimuli may provide further information regarding infants' understanding of visual and vocal aspects of emotion at 16-months of age. Infants are presumably more familiar with the visual and vocal expressions of emotion displayed by their own caregivers than the expressions of emotion posed by other individuals. It is possible the infants are capable of pairing "fearful" and "happy" facial expressions and prosody modeled by their own caregivers prior to demonstrating the ability to do so with expressions posed by unfamiliar models.

Another possibility would be to study infants' ability to match facial expressions and prosody when they are presented in context. Tying these expressions to an emotional event may aid infants in completing the task because it would provide a contextual basis for the emotions. One way of doing this would be to have an actress display facial expressions while performing an action. For example, an actress could portray happiness while building with blocks and surprise while playing with a jack-in-the-box. These videos could be played to infants while either matching or mismatching prosody is played. A control group could be tested using prosody paired with a video of the actress displaying a neutral face while engaging in the events. This would help to rule out the possibility that infants could be pairing the

event with the corresponding prosody, rather than the facial expression. Such a study could help to determine if additional context would aid infants in succeeding at a matching task involving similar emotions. In addition, these videos would likely be more entertaining than facial expressions alone, and thus could be useful in studying older infants.

Future research could also focus on infants' ability to learn concepts of emotion. Including a training phase prior to testing infants on their ability to pair facial expressions and prosody may provide a more detailed assessment of their capabilities. While16-month-old infants may not yet be capable of independently matching facial and vocal expressions of emotion, they may be able to do so when they are cued to focus on these aspects of emotions.

Finally, examining infants' ability to complete a matching task involving their own facial expressions may provide further information regarding early understanding of emotion. While 16-month-olds may not yet have a concept of the emotions of others, they may have a better understanding of their own emotions. Presenting infants with their own facial expressions during a matching task may provide further information regarding their abilities. It is possible that infants will relate to these expressions more readily and show a stronger understanding of the expressions that they produce themselves. While infants do not routinely view their own facial expressions, it is possible that they have come to understand emotion simply through the act of expressing emotion themselves. Such a study would provide further insight into a possible disconnect between early understanding of one's own emotions as compared to the emotions of others.

Conclusion

In conclusion, the lack of findings in the current study suggests that further research is necessary to expand our knowledge of infants' early understanding of the visual and vocal manifestations of emotion. Despite being insignificant, the results may help to narrow focus on a potential timeline of development of concepts of emotion. In addition, these results suggest that 16-month-old infants' understanding of the facial and vocal expressions of emotion does not involve categorizing emotions by valence. Examining understanding of these aspects of emotion in older infants using a variety of methods will help to expand research in this area and to determine whether or not infants' early gains in understanding of emotion are followed by a period in which they focus on learning other skills. When combined with additional research, these results may help us to understand the role that prosody plays in infants' understanding of emotion and how this early understanding develops from infancy into childhood.

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