YOUNG INFANTS' ATTENTION AND EMOTIONAL RESPONSES TO DYNAMIC AND STATIC BIMODAL DISPLAYS OF AFFECT

by Susan Parker-Price

Dissertation submitted to the Faculty of

Virginia Polytechnic Institute and State University

in fulfillment of the requirements for the degree of

Doctor of Philosophy

in

Psychology

Committee members:

Robin P. Cooper, Ph.D., Chair

Helen J. Crawford, Ph.D.

Robert E. Lickliter, Ph.D.

Sigrid B. Gustafson, Ph.D.

Marjorie Grene, Ph.D.

June, 1993

Blacksburg, Virginia

YOUNG INFANTS' ATTENTION AND EMOTIONAL RESPONSES TO DYNAMIC AND STATIC BIMODAL DISPLAYS OF AFFECT

by Susan Parker-Price

Committee Chair: Robin Panneton Cooper, Ph.D.

Psychology

(ABSTRACT)

This experiment was designed to elucidate the function of adult facial and vocal behavior for infant perception and expression of affect. Nine infants were studied longitudinally at 2 months and at 3 1/2 months using a dynamic visual display that consisted of a videotape of a woman moving her face while expressing happiness or sadness. A second group of 10 infants were studied similarly in a version of this procedure that used a static videotaped display of the woman's face in which she showed fixed expressions of either emotion. Both types of visual displays were accompanied by a soundtrack playing either affectively matched or unmatched infant-directed (ID) speech.

Infant visual fixations of the display area were determined during the experimental session by a trained observer who was kept unaware of the stimuli being presented. The sum of these fixations for infants in the Static condition was greater than that of infants in the Dynamic condition. A similar analysis of the average length of infants' visual fixations revealed no significant results.

Analyses of infant affect and "interactiveness" were also conducted by having trained raters score videotapes of each session using one of 4 rating scales. According to 2 of these measures, infant facial affect was more positive during displays that contained happy elements than during matched sad displays, and 3 1/2-month olds were more frequently rated as More Happy during matched happy displays. Thus, infants showed different affective responses to the 4 face-voice combinations, even though they did not attend differently to the displays. In addition, infant facial affect was more positive at 3 1/2 months because smiling at displays was more reliable at this age. The analysis of infant "interactiveness" revealed that 3 1/2-month olds in the Static condition were more "interactive" than those in the Dynamic condition.

A supplementary analysis of a questionnaire that was designed to measure parents' perceptions of their infants showed that almost 1/5th of the attrition at 2 months could be accounted for by infants' tendencies to respond negatively to novel experiences. The results of this study are discussed in terms of their implications for future research in infant perception.

ACKNOWLEDGMENTS

As is true for most major undertakings, the research and writing of this dissertation consisted of both painful and joyful moments. My husband, Tim, deserves the most recognition for the final product that resulted from this endeavor. Without his patience and love, my confidence and idealism could not have been maintained, and without his creativity and technical genius, the completion of this project would not have been possible. I would also like to thank my parents, Bruce and Christine Parker, my brother, Tom Parker, and my brother's fiancée, Meg Mortimer for their encouragement and support. Together, these family members have taught me to keep a sense of humor, a fascination with the unknown, and a commitment to understanding the world around me.

In addition to my family, many other people provided the social support and technical expertise that was necessary for the completion of this project and my degree. Anna, Jeff, Tamara, Dave, Jane, Tom, Mike, Heather, Jason, Rick, and Nancy are among those friends who shared the heights and depths of this experience with me. I would also like to thank the families who participated in this research and the many undergraduate lab assistants who contributed time and effort to this project. Special thanks goes to Lee Cooper who wrote the computer program used to operate the apparatus in this study, to Julie Hicks who devoted many long hours testing infants and analyzing videotapes, and to Dean Stamoulis and Sharon Flinder who contributed their expertise in quantitative methods during the final phases of this project.

Finally, I would like to thank various members of the faculty who have contributed to my professional development. I owe many thanks to my major professor, Robin Cooper, for contributing the support and guidance that made this project possible. It is my hope that we will develop a strong colleagial relationship over the next few years. In addition, I would like to thank Bob Lickliter and Helen Crawford for their professional advice and encouragement over the past few years, Sigrid Gustafson for her help with the quantitative aspects of this dissertation, and Marjorie Grene for her willingness to critique the final manuscript by telephone while she conducted business overseas. In the years to come, I hope I may live up to the expectations of all of the individuals mentioned above and that they may continue making positive contributions to the lives of students at various levels of professional development.

CONTENTS

TABLES

PAGE

FIGURES

Figure Captions

Figure 1. Design of infant perception apparatus displayed in overhead and side views

Figure 2. Average infant facial affect scores to the 4 combinations of happy and sad voices

Figure 3. Average infant interactiveness scores to static and dynamic displays at 2 and 3 1/2 months

Figure 4. Possible combinations of infant affective responses and attention to stimuli

Introduction

Social interactions between infants and their caregivers have been the object of many inquiries concerning human development because such encounters exemplify the usual context within which many ontogenetic changes occur. Specifically, studies of infant-adult face-to-face encounters have linked early social and intellectual development to variations in maternal behavior, infant behavior, and synchronous activity within mother-infant dyads (Crnic, Ragozin, Greenberg, Robinson, & Basham, 1983; Isabella, Belsky, & von Eye, 1989; Lester, Hoffman, & Brazelton, 1985). An important aspect of these early social interactions is the supralinguistic communication between infant and adult that results in appropriate responding from each member of the dyad. The ability to perceive and respond appropriately to adult displays of emotion, in particular, contributes a dimension to infant-adult interaction that foreshadows the subtle pragmatic aspects of spoken communication found in older children. Within the first few months of postnatal life, these aspects of infant social behavior become increasingly more complex during such interchanges (Emde & Gaensbauer, 1981; Fogel & Thelen, 1987; McLeod, 1991; Sroufe, 1979; Stern, 1974a; Stern, Beebe, Jaffe, & Bennett, 1977; Symons, Moran, & Acton, 1989). However, studies of ontogenetic change in infant-adult social interaction have failed to address the specific factors that may influence infant perception and expression of affect and how the role of such factors may change with development.

Infant Perception of Social Events

Alternatively, studies of infants' perception of faces, voices, and face-voice combinations have investigated the salience of such aspects of adults' social displays to infants. Within these studies, the term, salience, has been used to imply that adults' social signals are characterized by certain qualities which direct and focus infants' attention upon them. The degree to which an infant attends to a stimulus defines the salience of that particular stimulus for the infant. The concept of attention which is essential to this definition of salience has been defined as a combination of 3 functions in the adult literature: 1) orienting to sensory events, 2) detecting signals for focal (conscious) processing, and 3) maintaining a vigilant or alert state (Posner & Peterson, 1990). Measures of infant attention directly correspond to the first and third function in this model since they are characterized by orientation to and continued visual fixation of some display. The second function, whether infants detect and process signals, can only be determined when they respond differentially to stimuli.

The salience of a particular stimulus and increased infant attention to such stimuli are two interdependent concepts that refer to the same phenomena, early attentional preferences for particular types of stimuli. Attentional preferences in young infants can be investigated using a comparison procedure in which infants' preferences for one particular stimulus over other simultaneously presented stimuli are ascertained. Within this type of research, the finding that infants prefer a particular type of stimulation over another necessarily implies that they can discriminate the two. However, the absence of any preference for one stimulus over another does not preclude the possibility that infants were capable of discriminating them. Further, the finding that infants prefer a particular stimulus over other stimuli is frequently used to indicate that the "preferred" stimulus is "salient" to young infants.

The finding that particular stimuli increase attentional responding in infants can also be viewed from a functionalist perspective. That is, the social signals of adults to which infants attend preferentially may, in turn, function as important ingredients of particular developmental sequelae. For example, an adult who expresses joy to a young infant will probably be more likely to provide him/her with the types of social stimulation that facilitate optimal development, than an adult who ignores the infant or seems depressed when interacting with him/her. In this way, it is advantageous for an infant to prolong interactions with such potential caregivers by responding with particular social behaviors, such as gazing and smiling at the adults' face. Following this rationale, social displays by adults which contain elements that elicit such behaviors from young infants are frequently described as "salient" to infants because they may lead to experiences which improve their chances for optimal developmental outcomes (e.g., Brazelton, Koslowski, & Main, 1974; Dent, 1990; Field, 1981). In the present study, the development of infant attention and affective responding to combinations of facial and vocal expressions of emotion was examined, because the infants' ability to perceive and express affect is an integral part of the bidirectional communication that characterizes infant-adult social interaction.

Voices as Social Stimuli

Voices have been viewed as a particularly important aspect of early perceptual experience that occurs during infant-adult social interactions. The wide range of speech stimuli that are available to young infants may be examined along several dimensions: 1) the identification of the speaker (e.g., stranger or familiar caregiver), 2) the type of speech (e.g., infant-directed or adult-directed), and 3) specific characteristics within a type of speech (e.g., broad-band or narrow-band sounds). Within each of these dimensions, a combination of functional and experiential reasoning has been used to explain infants' preferences for speech stimuli and their ability to discriminate among voices.

The functional significance of infants' ability to distinguish among voices of potential caregivers has been used to explain the findings that newborn infants prefer the voices of their own mothers to those of other women (DeCasper & Fifer, 1980; Fifer & Moon, in press). Further, the finding that this preference is not evident when the mother's normal intonational pattern is eliminated suggests that differences in the suprasegmental aspects of maternal speech may underlie infants' identification of their mothers' voices (Mehler, Bertoncini, Barriere, & Jassik-Gerschenfeld, 1978). The presence of such abilities in newborn infants has led to explanations that emphasize the role of prenatal exposure to the attenuated voice of the pregnant mother in which the fundamental frequency (pitch) of voice intonation is dominant (Cooper & Aslin, 1990).

Despite this interpretation, total reliance on pitch contours as a predictor of infant preferences for specific voices may underestimate the importance of other types of suprasegmental information. In particular, the finding that newborn infants prefer spectrally complex sounds to pure tones (Turkewitz, Birch, & Cooper, 1972) suggests that from a very early age acoustic dimensions other than pitch may determine the salience of speech. Further, infants' preferences for their mothers' voices should not be overgeneralized at the expense of other sources of language input. It is important to remember that infants encounter many situations in which they are not required to choose between listening to their own mothers' voices and those of other men/women. Rather, the environments of young infants contain many incidences of speech which infants attend to based on a variety of preferred characteristics.

The tendency for such preferred characteristics of speech to occur together is maintained in research of infant perception of particular types of speech that are designed to reflect naturally occurring combinations of prosodic features. Such studies have demonstrated a fit between infant and caregiver, such that the type of speech which is most likely to sustain an infant's attention parallels the vocal patterns used by adults when addressing an infant or young child (Dent, 1990). This child-directed speech is a linguistic simplification of typical adult speech which is characterized by shorter utterances, more repetitions and expansion, better articulation, and decreased structural complexity (Garnica, 1977; Papousek, Papousek, & Bornstein, 1985). Because infants younger than 6 months are probably insensitive to such linguistic modifications, the prosodic features of infant-directed (ID) speech have been used to explain their preference for this type of vocal patterning.

The prosodic modifications that characterize ID speech may explain infant speech preferences within a variety of dimensions. Studies of this type of speech have typically emphasized pitch which shows wider excursions, a broader range, and a generalized tendency to be elevated in ID speech, relative to adult-directed (AD) speech (Cooper & Aslin, 1990; Fernald & Simon, 1984; Fernald, Taeschner, Dunn, Papousek, de Boysson-Bardies, & Fukui, 1989; Grieser & Kuhl, 1988; Stern, Spieker, Barnett, & MacKain, 1983). However, pitch is only one factor that determines infant preferences for types of speech. Additional characteristics that distinguish ID from AD speech include increased rhythmicity, slower tempo, longer pauses, and increased amplitude. Infant preferences for this combination of exaggerated prosodic features have been demonstrated as early as the first few days after birth (Cooper & Aslin, 1990) and at 1 month (Cooper & Aslin, 1990), 7 weeks (Pegg, Werker, & McLeod, 1992), 4 months (Fernald, 1985; Werker & McLeod, 1989), and 7 to 9 months postnatally (Glenn & Cunningham, 1983; Werker & McLeod, 1989). Moreover, the tendency for ID speech to invoke and sustain the attention of infants has led to the functional interpretation that the prosodic modifications of ID speech may facilitate early perception of affective expression (Fernald, 1984, in press; Werker & McLeod, 1989).

Studies of ID speech have demonstrated its affective salience for infant and adult listeners. In an investigation of the onset of social smiling, Wolff (1961, 1987) distinguished a high-pitched voice from a variety of other stimuli as the most effective way of eliciting smiles in 3-week-old infants. Since this early demonstration, studies that provide more detailed descriptions of speech stimuli have found that the affective meaning underlying vocal communication is more easily detected in ID speech than in AD speech. For example, Fernald (in press) found that 4-month-old infants responded with affectively matched facial expressions to Approval and Prohibition vocalizations in English, Nonsense English, German, and Italian only when these were presented using ID speech. Similarly, adult listeners have been shown to perceive the emotional tones of utterances, in several unfamiliar languages and in speech that has been filtered to eliminate linguistic information, more effectively in ID than in AD conditions (Fernald, in press; Fernald, 1989). These findings demonstrate the importance of ID speech for regulating emotional responding in infant and adult listeners and for facilitating affective communication during infant-adult social interactions.

Faces as Social Stimuli

The ability of very young infants to distinguish and respond appropriately to the emotional tone of adult voices has been more clearly explicated than their perception of facial expressions. One reason for this difference may be that the infant auditory system is fully functioning at birth, while the visual system does not reach adult levels of acuity until the sixth month of postnatal life (Aslin, 1987). The blurred vision of a 1-month old precludes detection of the finer facial features and results in more attention to highly contrasting areas of the face, such as the hairline (Maurer & Salapatek, 1976). In the second and third months of postnatal life, infants increasingly fixate the interior of the face, but this increase is attributed to the greater amount of time that infants spend looking at eyes, since scanning of the mouth and nose is similar in the first 4 months after birth (Haith, Bergman, & Moore, 1977). This increased attention to the eye area may provide the young infant with the first visual cues that he/she uses to distinguish among faces and their expressions.

Studies of infants' discrimination of facial stimuli have predominately focused on the third to sixth month of postnatal life when the scanning of interior facial features has become extensive. Using photographs of faces, such investigations have determined that 3-month-old infants can discriminate between faces of strangers that have been rated as similar by adults (Barrera & Maurer, 1981) and between happy and sad expressions (Young-Browne, Rosenfeld, & Horowitz, 1977). However, the ability of young infants to differentiate surprised expressions from either happy or sad expressions is uncertain. Curiously, 3-month-old infants can discriminate happy from surprised expressions (Young-Browne et al., 1977), while 4 1/2-month olds fail to differentiate these particular affective displays (Caron, Caron, & Myers, 1982). Differences in the photographed expressions that were used as stimuli in these studies may be responsible for this apparent discrepancy. However, since infants have been shown to increase their fixations to the nose and mouth areas of faces between 4 and 5 months of age (Caron, Caron, Caldwell, & Weiss, 1973), less accurate perception of facial expressions during this period could also indicate a developmental shift in visual scanning behavior which temporarily alters responding to such stimuli.

A second perplexing finding has resulted from investigations of the young infant's ability to discriminate facial stimuli. Such studies are usually conducted by habituating the infant to one stimulus and then replacing this first stimulus with the second. For example, the presentation of a happy face would be repeated for several trials until the infant's fixations were very brief, and then a surprised face would be presented. The appropriate control condition for this habituation paradigm consists of a continuous presentation of the happy face and can be performed as a within- or between-subjects manipulation. The ability to discriminate the surprised from the happy face (in the order that they were presented) would be evidenced by a recovery of attention in the experimental condition such that infants' looks to the surprised face exceed their looks to the continued presentation of the happy face in the control condition. Conditions that present the stimuli in the reverse order are frequently designed to eliminate order effects. That is, results for the above order, happy-surprised, would be compared to a similar condition that involved habituating infants to the surprised face before the happy face was presented.

Ideally, the ability to discriminate stimuli using this paradigm should not be affected by the order of presentation, but some studies of 3-month-old infants report asymmetric results for particular facial expressions. For example, 3-month-old infants seem to differentiate surprised from sad expressions, only when the sad expression is presented first (Walker-Andrews, 1988; Young-Brown et al., 1977). One common explanation of this asymmetric result is that sad expressions are uninteresting, or even aversive, to young infants and that this effect is intensified when surprised expressions are presented first (Walker-Andrews, 1988; Young-Browne et al., 1977). The logic of this explanation is as follows: after habituating to a surprised expression, infants show no increase in attention to a sad expression, even though they can discriminate the two, and this lack of response is attributed to the differential salience of the two stimuli. Not only does the use of hypothetical preferences as explanations for failures to discriminate contradict a basic assumption of discrimination research (i.e. that stimuli are equated for salience at the start of the procedure) but the plausibility of this interpretation is called into question by the absence of similar asymmetric results from other habituation experiments.

Based on the proposed explanation of the order effects which characterize infant habituation to surprised and sad expressions, corresponding asymmetries would be expected for happy and sad expressions. However, infant habituation to happy and sad expressions is unaffected by the order of presentation (Young-Browne et al., 1977). Since infant preferences for happy over sad facial expressions have been established empirically (LaBarbera, Izard, Vietze, & Parisi, 1976), the symmetric responding in this experiment cannot be attributed to equal salience of the stimuli.

In addition to these perplexing results, differences in the methods, which typify studies of infant perception of faces in the first 6 months of postnatal life, also obscure the ontogenetic changes that underlie this important ability. The static facial stimuli that have been used to demonstrate the perception of faces in infants 3 to 6 months of age stand in contrast to the live models and prerecorded dynamic visual displays, which characterize studies of younger infants. For example, Field, Woodson, Greenberg, and Cohen (1982) demonstrated the ability to distinguish happy, sad, and surprised expressions in newborn infants using a live model who held the infant and determined when to begin and end habituation trials. Although the questionable objectivity of the model as an observer and the likelihood of inconsistent stimulation across infants present difficulties for this procedure, the use of a live model rather than photographed faces may have contributed to neonates' perception of facial expressions. Further inquiries may determine the constraints that underlie the demonstration of the ability to discriminate facial expressions.

The perception of facial affect in infants younger than 3 months has been examined in only one other study. In this investigation, Nelson and Horowitz (1983) demonstrated the ability of 2-month olds to distinguish happy from neutral facial expressions using holographic stereograms of a moving face. This method avoided the problems associated with a live model, but preserved aspects of the model's facial expressions that may have facilitated infant perception. Although it remains unclear whether either the movement of the face or its 3-dimensional appearance contributed to the 2-month olds' ability to differentiate the expressions, it is clear that this distinction was made using only visual cues. Thus, infants younger than 3 months appear capable of distinguishing happy, sad, surprised, and neutral expressions when a dynamic 3-dimensional face is used (Field et al., 1982; Nelson & Horowitz, 1983). Unfortunately, the exclusive use of such displays in studies of very young infants has failed to explicate which types of visual information may influence this ability, thereby precluding the integration of this research with that of older infants. If researchers' decisions to use dynamic or static displays reflect a shift in the contingencies underlying the perception of facial expressions, infants younger than 3 months may be less capable of distinguishing facial expressions when they are presented as 2-dimensional static displays.

Face Movement and Infant Perception

The hypothesis that face movement facilitates infants' perception of facial expression is supported by a variety of studies which have demonstrated that infants prefer dynamic over static stimuli and that the increased attention which characterizes this preference may enhance infants' perception of certain stimulus qualities when movement is present. As early as the first few days of postnatal life, infants have been found to attend for longer periods of time to a geometric pattern when it is rotating or translating (moving side-to-side) than when it is stationary (Slater, Morison, Town, & Rose, 1985). By 4 months, this increased attention to dynamic displays facilitates infant perception of a variety of object characteristics. For example, 4-month olds provide no evidence that they perceive a form in a subjective-contour display when it is paired with a similar display that does not produce the illusion of a form (as judged by adults) (Shapiro, Haith, Campos, Bertenthal, & Hazan, 1983). However, they reveal a striking preference for the subjective-contour display when it is rotated. Dynamic displays have shown similar enhancement effects compared to static stimuli in studies of infant perception of the wholeness of partially occluded objects (Spelke, 1985), point-light representations of human forms (Bertenthal, Profitt, Spetner, & Thomas, 1985), and qualities of materials, such as rigidity and deformability (Gibson, Owsley, Walker, & Megaw-Nyce, 1979). Conceivably, young infants' perception of facial expressions may also be facilitated by movement of the face.

Studies of infant attention to moving and stationary faces have defined "face movement" in a variety of ways that, despite their dissimilarities, have almost always revealed infant preferences for dynamic over static faces. In particular, infants have been shown to prefer moving over stationary faces at 5 months when movement is depicted as a side-to-side oscillating motion (Carpenter, 1974) and at 3 and 4 (Kaufman & Kaufman, 1980) and 5 months (Wilcox & Clayton, 1968) when movement is depicted as an ongoing change in the internal features of the face (as when an expression is being formed). The finding that different types of face movement increase infants' attention to faces does not suggest that all types of face movement are equally interesting to young infants.

To date, only one study of the effects of various types of face movement on infants' attention to faces has been conducted (Haith et al., 1977). These researchers examined young infants' visual scanning of reflected images of a live model's (mother, unfamiliar male, unfamiliar female) face when the face was still, moved side-to-side, and moved side-to-side while talking. Whereas 3- to 5-week olds and 7-week olds showed no differences in the percent of time that they spent fixating the internal features of faces across these conditions, 9- to 11-week olds increased their attention to the interior of faces that moved and talked. Unfortunately, these results do not specify why talking facilitated scanning in the oldest group of infants, or why the performance of the younger infants did not change in response to more animated displays.

That the two younger groups of infants did not attend differentially to the 3 types of displays contradicts the findings of other research. In particular, Carpenter (1974) showed that 2- to 7-week-old infants increased their attention to the face of their own mother and two mannequin faces when they moved side-to-side instead of remaining stationary. Because Carpenter (1974) and Haith et al. (1977) defined side-to-side motion similarly as 8.25 cm and 10 cm respectively from center to side position, it is unlikely that the degree of movement from side-to-side produced these differences. However, Haith and his colleagues (1977) did not specify the velocity of head movement in their study, and neither study specified whether the side-to-side movement was accompanied by tilting of the head and/or movement of the shoulders. Variations in these factors may affect very young infants' attention to moving faces. In addition, Carpenter (1974) measured infant attention by having trained observers provide on-line records (generated by a series of button presses on an event recorder) of whether an infant was looking at the face, whereas Haith et al. (1977) measured infant visual fixations to particular areas of the face (e.g., eye-region, nose, mouth, hairline) by videotaping the sessions and using a computer program to calculate the amount of time that an infant fixated each region. Conceivably, the use of these different methods may have led to different conclusions in the two studies. The presence of such discrepancies suggests that before the second postnatal month aspects of moving facial stimuli, such as how quickly the face moves, whether face movement changes the orientation of the face (e.g., tilting to the side vs. continued upright orientation during side-to-side oscillation), the methods used to present faces (e.g., reflection of live model vs. live model), and the methods used to determine infants fixations, may affect the conclusions of this research.

The finding that 9- to 11-week-old infants in the Haith et al. (1977) study increased their attention to the face that moved side-to-side and talked is not discrepant with the results of other research. However, the combination of a voice and face within this stimulus makes it difficult to determine the characteristics of this type of display that facilitated infant attention. Possible explanations for the 9- to 11-week olds' increased attention in this condition include: 1) the complex movement of a talking face was more compelling than repetitious side-to-side changes in face position; 2) movement of the interior portion of the face focussed their attention on this area; 3) the presence of a voice facilitated visual fixation; and 4) the temporal synchrony of a voice and "talking" face was inherently attractive to the 9- to 11-week olds. Although Haith and his colleagues (1977) did not explore these particulars, their findings suggest that all dynamic visual displays may not be equal and that stimulation of multiple modalities (e.g. auditory, visual) may also affect infant perception of facial stimuli.

The different responses of infants to static and dynamic facial stimuli in these studies do not provide evidence that face movement facilitates infants' perception of emotion expressions. Nevertheless, the finding that infants typically look longer at moving faces parallels early preferences for dynamic non-face stimuli which have often been accompanied by evidence that this increase in attention facilitates infant perception. In the case of non-facial stimuli, one explanation of the importance of motion for infant perception is that dynamic stimuli focus young infants' attention on aspects of displays which are fundamental to the perception of particular qualities. To the extent that this explanation can be applied to facial stimuli, movement of the internal features of the face which has been shown to focus infants' attention on these regions (Haith et al., 1977) may be particularly well suited to promoting young infants' perception of the particular changes in these features that underlie facial expressions. These facilitative effects of movement on young infants' perception of faces may be further enhanced when a voice accompanies the visual display.

Infant Perception of Voice-Face Relations

In addition to increasing the attention of infants to faces, the combination of auditory and visual stimulation that occurs when an adult faces a young infant and talks to him/her may be particularly important for the development of associations between faces and voices. Wolff (1987) reported that whereas 5-week-old infants smiled in response to a high-pitched voice, this same stimulus induced visual pursuit movements in 8-week olds who typically delayed smiling until they had fixated a face. These results suggest that by 8 weeks of age voices facilitate attention to faces because infants have learned to associate these two types of events.

Once this coordination of visual and auditory information has been achieved, young infants must finely tune such associations so that they are able to detect subtle aspects of these bimodal (containing both visual and auditory elements) displays, such as the emotions that underlie particular combinations of vocal and facial gestures. Walker (1982) demonstrated this ability using a preference paradigm in which 5- and 7-month olds viewed two films of a woman acting happy or neutral simultaneously as a soundtrack matching one of the films was played. Even when cues of temporal synchrony were removed (i.e., by playing the soundtrack so that it preceded the behavior of the model on the film by 30 seconds), infants looked longer to the affectively matched film. Similar abilities have been demonstrated in 3- and 5-month-old infants using slides of sad and happy faces and recordings of affectively matched voices (Walker-Andrews & Grolnick, 1983). Thus, by 3 months of age, infants can identify the emotional tone underlying adult behavior from combinations of vocal and facial gestures.

Regrettably, knowledge of this type of intersensory perception prior to the third month of postnatal life is less complete. Haviland and Lelwica (1987) have conducted the only systematic study of very young infants' ability to perceive emotional expressions from a bimodal display. These investigators asked mothers to repeat particular utterances to their 10-week-old infants in a non-contingent manner (i.e., not responding to the infants' behavior) expressing joy, anger, and sadness. Infants responded to these noncontingent displays of emotion as follows: 1) happy displays induced matching facial expressions and decreased mouthing; 2) anger caused distress in some infants and matching of facial expressions in others; and 3) sad displays resulted in increased mouthing. While these findings help to describe the effects of several types of affective displays on very young infants, they fail to explain whether such early demonstrations of the perception of emotional expression results from auditory, visual, or bimodal information.

The finding that very young infants are capable of distinguishing a variety of affective displays during face-to-face encounters does not explain this important perceptual competence. During the first few months of postnatal life, infants have been shown to differentiate the dynamic facial expressions of a live model (Field et al., 1982) and the dynamic bimodal (face, voice) affective displays of their own mothers (Haviland & Lelwica, 1987). Neither of these investigations explored the role of auditory and visual information in young infants' perception of emotion. Further inquiries that use bimodal displays are needed to determine whether the young infant's perception of emotion is dominated by one modality or depends on the coordination of vision and audition.

Auditory Dominance in Young Infants

Although it is likely that infants perceive affect using a combination of information from faces and voices, some work has suggested that perception in the first few postnatal months is more heavily based on audition than on vision. Such explanations are based on research in the development of sensory modalities which has shown that the structural and functional development of the different sensory systems is asynchronous in many species (Bronson, 1982; Gottlieb, 1971). Perception in young infants may be affected by this ontogenetic pattern because asynchronous development of the human auditory and visual systems creates an imbalance in these modalities during the first few months of postnatal life. This imbalance is characterized by a combination of immature visual perception along several dimensions (i.e., acuity, contrast sensitivity) and auditory functioning that closely approximates adult levels (Aslin, 1987; Lewkowicz, 1988a).

Until recently, the concept of auditory dominance in young infants had only received support on theoretical grounds, but in the past few years several studies have provided evidence that this phenomenon exists. In particular, Lewkowicz (1988a) has demonstrated that infants as old as 6 months can discriminate temporal characteristics (rate, duration) in a pulsing sound and a flashing checkerboard when they are presented separately, but when these stimuli are presented simultaneously, 6-month olds can only discriminate changes in auditory components of these displays. In a subsequent study, 10-month-old infants showed equivalent responding to auditory and visual stimuli that were presented simultaneously using these same methods (Lewkowicz, 1988b). Lewkowicz (1988a, 1988b) interprets these results as evidence that infants respond to the particular stimulus compounds used with auditory dominance at 6 months but that the two sensory modalities become equivalent by 10 months. The consistent failure of the younger infants to respond to visual aspects of the compound stimulus was especially intriguing because by 6 months infant visual systems are nearly equivalent to adult levels (Aslin, 1987). This finding may suggest that a time lag exists between the development of the visual system and infants' abilities to utilize the 2 modalities.

Although no research has ascertained whether auditory dominance explanations can be applied to the perceptual capabilities of infants younger than 6 months, it is possible that early perception of face-voice relations may be affected by this imbalance. Because infants have more extensive experience with faces and voices than with checkerboards and pure tones, it is also likely that auditory dominance would only be found in very young infants whose perception of faces was still immature. As was previously mentioned, infants younger than 3 months do not scan the interior features of faces thoroughly unless the face is moving and talking (Haith et al., 1977). To date, no work has examined the possibility that infants' perception of adults' facial and vocal displays may demonstrate auditory dominance. Conceivably, early perception of bimodal expressions of affect could be influenced by the imbalance that exists between auditory and visual modalities during the first 6 postnatal months, as well as by stimulus qualities, such as face movement.

Infant Expression of Facial Affect

While engaged in a face-to-face encounter with an adult, a young infant must communicate affect as well as perceive it, thereby enabling a bidirectional interchange between individuals. In this sense, the social behavior of young infants has been hypothesized to serve a mediating function, such that the type and amount of social stimulation that an infant receives is optimized when an adult responds to his/her cues appropriately (Brazelton et al., 1974). Behavioral descriptions have led to the classification of negative and positive affective responding in infants as early as the first few days after birth (Brazelton, 1983). Specific indices of positive responding in newborn infants include, decreased motor activity, maintenance of a quiet-alert state, and the direction of prolonged gazes toward the social partner's face, while negative responding is characterized by gaze aversion and crying (Brazelton, 1983). Although these behaviors have been used to indicate the facilitative effects of various types of social stimulation on infant attention, they do not include the subtle type of cue that is exemplified by infant facial expressions. These widely recognized affective signals add a dimension to research in infant perception of social events which may lead to further inferences about the character of infant-adult interchanges.

Even newborn infants modify their facial expressions during social interactions by demonstrating facial and eye "softening", an alleged precursor of smiling (Brazelton, 1983), and by imitating adult facial expressions (Heimann, 1989; Meltzoff & Moore, 1977). Moreover, detailed behavioral observations of infants during the first 3 postnatal months have identified characteristic facial expressions and/or related motor behaviors associated with 3 categories of emotion: interest, joy, and distress (Emde, 1980; Emde, Gaensbauer, & Harmon, 1976). Although it is unclear how the feeling states of young infants correspond to these early patterns of behavior, similarities across cultures in the perception of emotions that underlie facial expressions establish their significance to adult social partners (Ekman, 1972; Izard, 1971, 1977).

The universality of particular facial gestures results in the transmission of subtle signals by infants, which responsive adults use to facilitate social interaction (Brazelton et al., 1974). Specifically, expressions of positive (e.g., joy, interest) and negative (e.g., distress) affect have been found to influence adult perceptions of infants and their behaviors during face-to-face encounters. For example, Werker and McLeod (1989) demonstrated that video-taped segments of infants showing positive expressions were rated as more pleasant, friendly, likeable, and cuddly by adults than segments in which the same infants responded less positively. Additionally, Malatesta and Haviland (1982) reported that mothers responded to the distress of their young infants during face-to-face interactions by first showing concerned or sad faces, then quickly changing to a joyful countenance which was characterized by exaggerated facial and vocal gestures. Such examples illustrate the character of infant-adult social interaction, which is dominated by adults' efforts to prevent infant distress while facilitating expressions of interest and joy (Malatesta & Izard, 1984; Symons, et al., 1989).

Development of Facial Expressions in Infancy

Of the many facial expressions that infants display in the first few months after birth, the smile is probably the most salient signal to adult social partners (Malatesta & Izard, 1984). Although newborn infants smile spontaneously during irregular sleep (i.e., sleep characterized by Rapid Eye Movements and increased motor activity), such nonsocial smiles have been distinguished from those that are elicited by social stimuli (Wolff, 1961, 1987). The average age of onset of social smiling has been a topic of controversy, with some researchers reporting its reliable occurrence as early as 3 weeks (Wolff, 1961, 1987) and some as late as 3 months (Emde et al., 1976; Spitz & Wolf, 1946).

These discrepant findings may result from differences in the methods used to elicit social smiles and the criteria used to establish their occurrence. Specifically, Wolff (1961, 1987) elicited smiles from 3-week olds by speaking in a high-pitched voice, whereas other researchers have required that infants reliably demonstrate smiles when a human face is presented (Ambrose, 1961; Emde et al., 1976; Spitz & Wolf, 1946). Additionally, Emde and his colleagues (1976) defined social smiling as a change in the relative frequency of this behavior such that by 3 months infants reserve smiling almost exclusively as a response for social events.

Although it is unclear why nonsocial stimuli, which promote smiling as effectively as social stimuli before the third month, lose their affective salience for young infants, the delayed onset of social smiling has been linked to aspects of caregiver-infant interaction. For example, Ambrose (1961) found that institution-reared infants developed reliable smiling in response to a human face between 9 and 14 weeks of age, whereas home-reared infants demonstrated this tendency as early as 6 to 10 weeks. Spitz and Wolf (1946) reported several severe disturbances in the onset of social smiling, including negative facial expressions (frowns and looks of puzzlement) and persistent gaze aversion, which they related to various forms of parental neglect. In typical home-reared samples of infants, however, positive facial expressions (smiling and eyebrow raising) during face-to-face encounters show an increasing pattern after the eighth postnatal week (Symons et al., 1989).

Whereas social smiling and eyebrow raising have been interpreted as signals that demonstrate the young infant's receptiveness to further stimulation, combinations of frowns, lowered eyebrows, and turning away (gaze aversion) have been construed as indicators of overstimulation, disinterest, or aversion to aspects of the social exchange (Fernald, in press; Brazelton et al., 1974; Stern, 1974b;

Symons et al., 1989). Interestingly, emotional expression and the direction of gazing are related, such that young infants display smiles when facing their social partners and negative facial expressions while averting their gazes (Symons et al., 1989). Heiman (1989) has also demonstrated that infant imitation of facial expressions and the tendency to discontinue eye contact are negatively correlated. That is, infants who demonstrated frequent imitation during social interaction at 2 to 3 days, 3 weeks, and 3 months postnatally also were less likely to avert their gazes at 3 months of age than infants who showed infrequent imitation. Predominantly, the negative facial expressions of infants have been examined in conjunction with expressions of positive affect and attention during infant-adult interaction as indicators of infants' preferences for particular types of social stimulation.

Social Stimuli That Elicit Infant Facial Expressions

Detailed observations of social interaction between infants and adults have provided descriptions of affective displays that typify the environments of young infants. Malatesta and Haviland (1982) reported that whereas mothers of 3- and 6-month-old infants restricted their expressions of emotion almost exclusively to the positive expressions of interest (e.g. joy, brow flash, and surprise), the range of facial gestures displayed by infants during face-to-face interactions included several negative expressions (e.g. sadness, anger, pain, knit brow). Further, McLeod (1991) reported that mothers selectively responded to their infants' behaviors at 7 and 20 weeks postnatally but that maternal behavior was not contingently related to infant frowns and knit brows at either age. Infants in these two studies failed to demonstrate behavior that was contingent upon specific maternal expressions of emotion. However, studies of infant responding to affective displays suggest that types of selective emotional responding may still occur at very early ages.

In particular, manipulations of maternal affect during face-to-face interactions have demonstrated three characteristic patterns of selective responding: 1) reflection or imitation, 2) persistent displays of an alternate mood, and 3) distress. Reflection of adult affect seems to predominate when adults express positive emotions toward infants. For example, Haviland and Lelwica (1982) found that 10-week-old infants consistently matched the happy expressions of their mothers but that imitation did not occur reliably for angry and sad displays. Instead, some negative emotions may elicit a nonimitative form of reciprocity, such that infants increase their positive expressions in an attempt to change the affect of their partner. Cohn and Tronick (1983) demonstrated this tendency in 3-month-old infants, who reacted to their mothers' simulations of a depressed state by initially increasing the number of smiles directed toward the unhappy parent. Moreover, when mothers prolong their displays of depression (Cohn & Tronick, 1983) or assume a "frozen" unresponsive countenance (Tronick, Adamson, Wise, Als, & Brazelton, 1975), 3- to 4-month olds become distressed, a reaction that may reflect infants' displeasure at not having their positive expressions reciprocated (Malatesta & Izard, 1984).

Although the reciprocal character of infant-adult interaction is diminished in studies of infant preferences, descriptions of facial expressions have provided a more detailed analysis of the particular social stimuli that elicit qualitatively different responses in the first few months of postnatal life. For example, female voices that display the characteristic modifications associated with ID speech have been found to increase infant affective responding (Fernald, in press; Werker & McLeod, 1989). Specifically, Werker and McLeod (1989) found that 4- to 5 1/2- and 7 1/2- to 9-month-old infants displayed more positive facial expressions in response to a videotape of an actor talking in ID speech than to comparable displays of the same actor talking in AD speech. This effect was particularly pronounced when the actor was female. The ID speech that comprised these stimuli were probably typical of a majority of utterances directed toward infants in that they communicated positive affect to the listener (Malatesta & Izard, 1984).

Alternatively, ID speech that conveys negative affect may be less common during infant-adult interactions (Malatesta & Izard, 1984), but supralinguistic aspects of these vocalizations distinguish their emotional tone from that of positive ID utterances (Fernald, 1989, in press). Fernald (in press) compared the affective responding of 5-month-old infants to negative (prohibition) and positive (approval) vocalizations in unfamiliar languages using AD and ID speech. The results of this investigation suggested that infants respond with differentiated affect to negative and positive vocal expressions that are presented using ID, but not AD, speech. That is, in the ID condition, infant affect, as measured by a 5-point facial affect scale, was more positive during statements of approval and less positive during statements of prohibition. Evidence of early preferences for ID speech (Cooper & Aslin, 1990) and the finding that social smiles can be reliably elicited at 3 weeks by a high-pitched voice (Wolff, 1961, 1987) suggest that ID speech may also elicit emotional responses in very young infants. To date, no detailed analyses of the affective salience of speech stimuli have been conducted for infants younger than 4 months of age.

In contrast to the paucity of work that has examined infant affective responding to voices, a large number of studies has used facial stimuli to elicit discrete expressions of emotion in young infants. In particular, investigations of social smiling have examined aspects of the human face, which may provoke this type of expression in young infants. Spitz and Wolf (1946) identified three features of facial stimuli that were necessary for the elicitation of social smiles in 3- to 6-month-old infants: 1) the presentation must take place completely "en face" (i.e., facing the infant); 2) two eyes must be shown; and 3) the configuration must include the factor of motion. Subsequently, Polak, Emde, and Spitz (1964) suggested that the 3-dimensionality of a display became increasingly important as an elicitor of smiles during the second month of postnatal life. This fourth criteria for facial stimuli was established by comparing the latency and persistence of infant smiles to a "nodding" life-sized cut-out color photograph of a face to a nodding live model's face. The gradual decrease over the second postnatal month in these two measures of smiling when the photographed face was presented demonstrate the interdependence of the ontogeny of perception and affective responding.

Conclusions and Hypotheses

To date, research of infant perception and expression of affect has failed to elucidate the specific aspects of social stimuli that facilitate infants' selective responding during social interaction. Infants younger than 3 months of age have been shown to discriminate and to modify their facial expressions in response to various affective displays. However, the methods used to demonstrate these abilities differ from those that typify work with older infants. Specifically, studies of very young infants' perception of facial expressions have been characterized by 3-dimensional dynamic facial stimuli, whereas infants older than 3 months have been studied using a wide variety of displays. Additionally, no investigations of infants younger than 4 months have examined the affective salience of vocal stimuli. These deficits in the literature suggest two aspects of adult behavior that may facilitate infant selective responding to affect during early face-to-face encounters with caregivers, facial movement and the emotional tone underlying ID speech. The present study examined the development of young infants' ability to recognize the relation between auditory and visual information in adult displays of two emotions, happiness and sadness.

Infants were studied at 2 months (8-10 weeks) and 3 1/2 months (14-16 weeks) postnatally, a period when the development of emotional expression and regulation of attention have been described as particularly rapid (Ambrose, 1961, 1963; Emde et al., 1976). Whereas previous work has demonstrated the capacity of 3-month-old infants to distinguish static facial stimuli (Barerra & Maurer, 1981; Walker-Andrews & Grolnick, 1983; Young-Browne et al., 1977), this study compared the responding of 2- and 3 1/2-month olds longitudinally to static and dynamic visual displays.

Because no research has systematically examined the effects of concurrent auditory and visual information in infants younger than 3 months, the effect of this manipulation on 2-month-old infants was unknown. Conceivably, the high salience of ID speech could have caused very young infants to discriminate affect that is presented aurally, while ignoring differences in the visual displays. At 2 months, this predominance of auditory information was expected to result in infants appearing relatively insensitive to visual information. Alternatively, 2-month olds were hypothesized to show a preference for affectively matched displays when a dynamic face was used. This bimodal perception of emotion was expected to occur in 3 1/2-month-old infants regardless of the type of visual stimulation. At both ages, infant facial expressions were examined to further differentiate attentional responding to affective displays.

Infant facial expressions could have either reflected or displayed an alternate mood in response to the perceived affective expression. Reflection would be evidenced if infants showed smiling and raising of eye brows during happy displays and sober expressions or frowns in response to sad displays. Conversely, if infants differentiated the two types of affective information but showed positive facial expressions for both emotions, this result could be interpreted as a combination of reflection and display of an alternate mood (Malatesta & Haviland, 1982; Malatesta & Izard, 1984). Longitudinal comparisons were hypothesized to reveal an increase in positive facial expressions from 2- to 3 1/2-months.

Method

Subjects

This study examined the attentional responses of 19 infants longitudinally at 2 months (8-10 weeks) and at 3 1/2 months (14-16 weeks) of age. Ten of these infants (7 males, 3 females) received static visual stimuli, whereas the other 9 (6 males, 3 females) received dynamic visual displays. Video-tapes of 18 of these infants (10 in the Static group and 8 in the Dynamic group) served as the basis for the analysis of their emotional responses to the stimuli that were presented. An equipment failure precluded the examination of the ninth infant's video-tape for the second visit.

Thirty two additional infants were tested but not included in the main study for various reasons. Twenty-three infants were excluded from the study at 2 months because of excessive fussiness. Additionally, 3 infants were excluded because they appeared drowsy or slept during the 2-month session. Four infants completed the 8-trial session at 2 months but had to be dropped from the study because they failed to complete all 8 trials at 3 1/2 months due to excessive fussiness. One infant who viewed static faces completed the 2-month session successfully but had to be dropped from the study due to an equipment failure during the 3 1/2 month visit. Lastly, 1 infant who received dynamic stimuli at 2 months was excluded, because her family was out of town during the 2-week period when their baby was within the age range for the second test session. The parents of 31 of these infants completed a 14-item questionnaire during the 2-month session, which was used in a supplementary analysis in an attempt to examine the contribution of individual differences to this attrition. The attrition in this study did not appear to be related to group (Dynamic vs. Static) or gender.

The attrition rate of the present study (63%), if examined as 2 separate rates for the 2-month (51%) and 3 1/2-month sessions (24%), is comparable to that of other studies that have investigated infant perception at these ages. Because fixed-trial preference procedures with more than 4 60-sec trials have not been used previously to investigate infant perception of bimodal stimuli at 2 months, the most suitable comparisons of attrition rates at this age that can be made are from studies that used infant-controlled habituation procedures and fixed-trial matching procedures. Such studies report attrition rates as high as 55% for 2-month-old infants (Pegg et al., 1992) and 42% for 3 1/2-month olds (Walker-Andrews, Bahrick, Raglioni, & Diaz, 1991).

All infants who participated in this study were recruited from local birth announcements in the <u>Roanoke</u>

Times and World News. Testing sessions were scheduled at a time of day when parents reported that their infant was usually awake (typically between the hours of 9:00 and 12:00 a.m.), and calls were made to parents on the day of the visit to insure that the infant was healthy and had not been unusually wakeful the night before.

Apparatus

Infants participating in the study were positioned in an infant seat within a 80-cm (length) X 80-cm (width) X 60-cm (height) wood enclosure facing the visual display area (40 cm from the infant's face). The interior of the wood apparatus was equipped with two small lights, one behind the infant's head to signal the beginning and end of each trial for observers and one directly in front of the infant to draw his/her attention away from the display area between trials. On the outside of the enclosure in front of the infant was a 40-cm X 80-cm shelf that supported an Emerson VCR-875 videocassette player/recorder which was used to play the stimuli during trials. A 13" Mitsubishi (model #CS1347R) color television monitor positioned above the videocassette player/recorder and to the right of the infant on a 50-cm X 21.25-cm shelf was used to present the visual stimuli. Infants viewed the screen of the television monitor through a cut-out in one wall of the enclosure which was tilted inward at an 85° angle. The soundtrack of the videotape was played within the enclosure at approximately 65 dB (C Scale) from a Realistic Minimus-7 speaker located in front of the infant and below the visual display. A Panasonic VHS camcorder (model #AG-HT4) recorded the activity of infants through a second cut-out in the front wall of the enclosure for subsequent analyses of affective responses. This camcorder also generated a visual display of each infant on a 5" JVC (model #TM22U) color television monitor during the procedure. Figure 1 shows the design of this apparatus.

Insert Figure 1 Here

The bimodal stimuli consisted of videotaped sequences of dynamic (moving talking face) or static (still face) affective displays of an adult female that were accompanied by the same woman's ID speech. The dynamic facial stimuli were obtained by videotaping a mother talking to her 4-month-old infant in a happy or sad manner, and the static facial stimuli were generated by having the same woman display posed expressions of the two emotions. Estimates of the luminance of each of the 4 types of visual displays were determined by computing average luminance levels from 6 areas of each face (i.e., forehead, eyes, mouth, chin, right cheek, left cheek). A Minolta Luminance Meter 1° (#153) was used to obtain measures of luminance in each of these areas. The average luminance levels showed that the static sad face (35.05 lumens), static happy face (35.05 lumens), dynamic sad face (31.61 lumens), and dynamic happy face (33.39 lumens) were characterized by similar levels of light energy.

Samples of happy and sad ID speech were obtained from the same mother talking to her infant during the dynamic interactive sequences. Voice samples consisted of a series of utterances that were selected because they were uninterrupted samples of ID speech that exemplified the desired affective tone. These speech samples were dubbed onto portions of the test tapes, so that voices representing each type of affect were paired with each type of face.

In order to determine whether the stimuli reflected the desired emotions, 8 adults (2 males, 6 females) were asked to rate the faces and voices. The rating procedure consisted of asking the adults to view or listen to the stimuli and then write a one-word description of the emotion that was being expressed. By allowing the adults to generate their own descriptions rather than giving them a choice of words, this rating system was less prone to the biasing effects of methods that use preselected categories.

The results of these ratings indicate that the stimuli closely approximated the desired emotion categories. The happy and sad voices were perceived as the intended emotions by 100% and 75% of the adults, respectively. Similarly, the happy and sad static faces were each rated as their intended emotion by 75% of the adults. The dynamic happy face was labelled as happy by all of the adults, and the dynamic sad face was described as sad by 50% of the adults. Although these results suggest that the range of emotions expressed by some of the faces and voices was greater than had been expected, a close examination of the variability of these ratings suggested that the adults frequently described the displays using words that closely resembled the intended emotion. For example, when the adults rated stimuli as some other emotion, they described sad faces and voices as "upset", "worried", or "concerned", and they rated happy stimuli as "pleased". According to Ekman (1972), the finer discriminations that were made by some of the adults in this study are not uniformly recognized across all cultures. Like members of some pre-literate societies, young infants in the United States may recognize fewer categories of emotion expression than adults of this culture (Caron et al., 1973). The use of these general categories would result in infants' perceiving closely related emotions, such as sad and upset, as belonging to one category. Following this rationale, it was determined that the stimuli used in this study approximated the desired emotions to a degree which was suitable for research with very young infants.

Dubbing of the voices onto the videotapes was performed so that test trials consisted of both matched (e.g., happy face w/ happy voice, sad face w/ sad voice) and mismatched (e.g., happy face w/ sad voice, sad face w/ happy voice) affective displays. However, the dynamic face-voice combinations that were constructed using this method contained a potential confound. Specifically, dynamic faces could be presented as temporally synchronous with affectively matched voices so that vocal activity and face movements were associated, but such temporal synchrony could not be produced between dynamic faces and affectively mismatched voices. Because young infants have been found to show preferences for temporally synchronous bimodal events (Kuhl & Meltzoff, 1984; Spelke, 1976, 1979, 1981), the voice used in this study was intentionally dubbed onto the video portion of the tapes of dynamic faces so that it played asynchronously with the woman's facial gestures in both matched and mismatched trials. Thus, the potential biasing effects of voice-face synchrony were eliminated from the study by ensuring that all trial types contained temporally asynchronous audio-visual displays.

Two tapes of randomly ordered combinations of happy and sad bimodal stimuli were constructed, 1 tape with a static visual display and 1 tape with a dynamic visual display. Both video tapes consisted of 11 60-sec stimulus presentations that were separated by a 3-sec black screen. The 3-sec black screen was originally designed to accommodate the length of the videotape that was required for the equipment to stop and start without reducing the time that the stimulus was displayed. A MacIntosh SE-30 Computer controlled the videocassette player and signal lights and recorded onsets and offsets of infant visual fixations in 100ths of a second by way of an interface so that stimulus presentations and on-line recording of observations functioned autonomously.

Procedure

Upon arrival, the parent (typically the mother) of each infant read and signed an informed consent form, which provided a brief account of the laboratory procedure and stated that they could request that the session be terminated at any time (see Appendix A). At the 2-month visit, the parent was also asked to complete a 14-item questionnaire, designed to measure parents' perceptions of their infants' behavior in situations that are similar to the laboratory procedure (see Appendix B). This questionnaire was comprised of 8 of the original 24 items from the Infant Characteristics Questionnaire (Bates, Freeland, & Lounsbury, 1979) and 6 added items which were designed to measure infants' experience and typical responses to face-to-face interaction.

An awake alert state, as defined by Wolff (1966), was initiated in all infants before beginning the testing procedure by some combination of the following interventions: 1) providing various forms of vestibular stimulation to rouse or soothe the infant, 2) interacting in a face-to-face manner with the infant, 3) feeding (breast/bottle), and 4) diaper changing. Once an awake alert state was initiated, infants were required to maintain this state for 8 consecutive trials in order to be included in the study. In the event that an infant cried, fussed, or became drowsy during the first few trials of the procedure, the experimenter attempted to regain a state of quiet alertness using the above interventions, so that the procedure could be restarted.

All infants were tested using an infant preference procedure (Columbo & Bundy, 1981), which consisted of a series of 8 60-sec trials that presented combinations of happy and sad stimuli bimodally. This sequence of trials included 2 trials each of the 4 affective combinations: sad face with sad voice (SFSV), sad face with happy voice (SFHV), happy face with sad voice (HFSV), and happy face with happy voice (HFHV). Table 1 illustrates these combinations of affective stimuli under dynamic and static visual conditions for infants at 2 months and at 3 1/2 months of age.

Insert Table 1 Here

The total time (measured in 100ths of a second) that an infant spent fixating the visual stimulus was judged during the procedure by a trained observer who was "blind" and "deaf" to the presentation of stimuli. The observer was kept unaware of the type of bimodal affective display by having him/her wear earphones that played music which masked the sound of the video tape and by having him/her view the infant's face on a 5" color television monitor which prevented the observer from seeing the visual stimulus. The training of observers who judged infant fixations consisted of a practice session during which they judged the fixations of infants who had been videotaped during pilot sessions or experimental sessions that had occurred recently. Because it was necessary that the infant's first fixation begin after it had been looking away from the display area, observers were also taught to begin each trial as soon as the infant stopped fixating the stimulus presentation area during the intertrial interval. The light behind the infant's head helped observers to determine when these intertrial intervals occurred.

The comments of these trained observers were used to determine whether sessions should be included in the final analyses of this study. After each session, the experimenter who oversaw the running of the procedure questioned the observer about how confident he/she felt about judging that particular infant's fixations. These statements were included in a brief report of the session which was written at the end of each session. Agreement by both the experimenter and the observer that a session had been of good quality was required before that session could be included in the main study. Such decisions were made before analyzing the data. However, no inconsistencies between the comments of the experimenter and individual observers occurred, so no sessions were eliminated from the study as a result of this criterion.

<u>Analysis of Infant Affect and "Interactiveness"</u>

Subsequent analyses of the videotaped sessions were performed to assess infant affective expression. As suggested in the initial proposal, infant expressions of facial affect were coded using a modified version of a rating scale used by Fernald (in press) in a study of 4-month olds' affective responses to ID speech. The revised scale consisted of 5 categories of infant facial expression, ranging from negative (1) to positive (5), and a sixth category that was used to distinguish times when the infant did not look at the display area (0) (see Appendix C). Videotaped sessions were coded using a time-sampling procedure in which 10 5-sec epochs of each 60-sec trial were judged based on the infant's dominant affective expression. The first and last 5-sec epoch of each trial were dropped because infants frequently showed pupillary responses, raised eyebrows, or forward lunging in response to the sudden onset of the stimuli, and also to insure that the stimulus consisted of both auditory and visual components for the entire 5-sec epoch. This second difficulty resulted from limitations of the equipment that occasionally caused the first or last few seconds of a trial to contain a portion of the 3-sec black screen which was recorded on the videotape. Epochs that received scores of 0 were dropped before computing the mean emotion score rating, because such scores indicated that infants had not looked at the display area throughout the epoch and, thus, infant affect could not be described as a reaction to the simultaneous presentation of visual and auditory stimuli. Raters of these videotaped sessions were trained in the observation of relevant infant behaviors and were kept unaware of the specific hypotheses being tested. Raters viewed the videotapes with the sound turned off, so that they remained unaware of the stimuli being presented.

Several additional measures of infant affective responding were created in an effort to more thoroughly examine the effects of Condition Type (Dynamic vs. Static), Age (2 months vs. 3 1/2 months), and Trial Type (HFHV vs. HFSV vs. SFHV vs. SFSV). One of these measures was a dichotomous variable on which infants were rated according to whether or not they smiled while looking at the display area during each trial (Presence / Absence of Smiling). Scores for this variable were determined by examining the emotion scale scores for individual epochs.

Other ratings of infant affect were conducted by having raters watch an entire trial once with the sound turned off and then rate it according to 2 measures that were more global than the infant facial expression scale. The first of these more global measures of infant affect required raters to judge whether an infant was More or Less Happy (for that particular infant during that particular session) during each trial (see Appendix D). This dichotomous measure was based on the work of Trehub (personal communication, 1993), who developed it as a way of eliminating the tendency of raters to select "neutral" affective categories while coding emotion expressions of young infants.

Another measure of infant social behavior was developed from a scale used by Werker & McLeod (1989) to rate the degree to which infants appeared socially interactive in response to face-voice stimuli. In the present study, trained raters scored infants on a 9-point Likert scale that ranged from "not interactive" (1) to "ambivalent" (5) to "very interactive" (9) (see Appendix D). Raters were instructed to regard interactiveness as separate from infant affect, such that an infant could be coded as "More Happy" and as "not interactive" for the same trial. Raters who used the more global measures of infant responding were trained by having them practice rating tapes from another study that had already been coded using these measures and compare their ratings to those of experienced raters.

Results

Infant Attention

Two measures of infant attention were computed from the raw data of individual fixation times recorded by the computer-controlled infant perception apparatus. The first of these variables consisted of the sum of the durations of all fixations during a trial and was called Total Looking Time. A 2(Condition) X 2(Age) X 4(Trial Type) Mixed Analysis of Variance (ANOVA), with Condition (dynamic vs. static) as the between subjects factor and Age (2 mos vs. 3 1/2 mos) and Trial Type (SFSV vs. SFHV vs. HFSV vs. HFHV) as the within subjects factors, was used to analyze the dependent variable, Total Looking Time. The results of the ANOVA revealed a significant main effect for Condition, $F(1,17)=4.81$, $p<.05$, indicating that infants in the static condition ($M=47.57, SD=4.07$) spent more time looking at the display area than those in the dynamic condition ($M=44.25, SD=4.28$). No other significant main effects or interactions were found (see Table 2).

Insert Table 2 Here

Because most infants showed multiple fixations during each trial, a second measure of infant attention was developed by computing the average look duration for each trial. That is, the duration of each individual look during a trial was summed and divided by the number of looks. However, if the infant was looking at the monitor when the trial ended, that last look was artificially truncated. These truncated looks were not included in the calculation of the Average Look Length measure. The only exception to this rule occurred in cases where an infant looked only once. For these trials, the single truncated look was included when Average Look Length was calculated (i.e., Total Looking Time / 1). The use of Average Look Length was supported by the finding that very few truncated looks had longer durations than the shortest non-truncated look within a particular trial. Indeed, many of these truncated looks were less than 1/10 sec in length. Thus, for most trials, the elimination of truncated looks did not reduce the Total Looking Time for that trial by very much. A 2(Condition) X 2(Age) X 4(Trial Type) Mixed ANOVA revealed no significant effects for the dependent variable, Average Look Length (see Table 3).

Insert Table 3 Here

Infant Affective Responses and "Interactiveness"

Infant emotion expression was first examined in an analysis of the average scores of the infant facial affect coding system for each Trial Type at each Age. Ratings of the trained observers who coded videotapes using this system were tested for reliability by having another trained rater code a randomly selected subsample of 9 sessions (4 at 2 months, 5 at 3 1/2 months) and then correlating this subsample with the original raters' mean scores for each Trial Type within these 9 sessions. A Pearson Product-Moment Correlation revealed a high correspondence between the two sets of infant facial affect ratings, $r = .86$, $p < .0001$.

Like the attention variables, mean infant facial affect scores were subjected to a 2(Condition) X 2(Age) X 4(Trial Type) Mixed ANOVA. This analysis revealed a significant main effect for Age, $F(1,16) = 5.40$, $p < .05$, and a marginally significant effect for Trial Type, $F(3,48) = 2.61$, $p < .06$. The main effect for Age showed that at 3 1/2 months facial affect scores were higher ($M = 3.57$, $SD = 0.29$), signifying more positive facial expression, than at 2 months ($M = 3.30$, $SD = 0.28$).

Insert Table 4 Here

The marginal effect for Trial Type suggested that infant facial affect was less positive during matched sad displays ($M = 3.32$, $SD = 0.20$) than during either SFHV

(M=3.42, SD=0.28), HFSV (M=3.46, SD=0.24), or HFHV (M=3.50, SD=0.22) displays (see Figure 2). No other significant main effects or interactions were revealed in this analysis.

Insert Figure 2 Here

Although the microanalytic technique of averaging individual epochs to obtain infant facial affect scores provided a highly accurate measure of infants' responses, these types of measures may not reflect the perceptual processes of adults who interact socially with young infants. To more effectively examine infants' responses as they are perceived in "real" time, several macroanalytic methods were added to this study. The first of these new measures was a dichotomous variable on which raters judged whether infants were More Happy or Less Happy during each trial. This variable was used, because it was possible that the option of a "neutral" category in the infant facial affect Likert scale might have made this coding system insensitive to the detection of subtle affective responses. A dichotomous affective scale prevents mean scores from remaining close to center of the scale and forces variability. In addition, the process of rating individual 5-sec epochs and then computing a mean from these was changed to a more global rating procedure in which a single rating was given after a trial had been viewed in its entirety. This new rating procedure was used, because the computation of means of infant facial affect scores had also contributed to the low variability of this measure.

The reliability of the More Happy / Less Happy measure was tested using the same methods as the infant facial affect coding system. However, another subsample of 9 recorded sessions (4 at 2 months, 5 at 4 months) was randomly selected and rated a second time for a reliability comparison. A Cohen's Kappa revealed a high agreement of the 2 sets of ratings of More Happy / Less Happy, k=.70 (95% confidence interval = $.56<k<.84$).

The scores for each Trial Type at each Age were then subjected to several Chi Square analyses to determine whether effects for the More Happy / Less Happy measure could further elucidate findings from the infant facial affect coding system. A Chi Square across the 4 Trial Types at 2 months revealed no significant differences in this affective measure as a function of affective display, $X^2(7)=3.44$, $p<.8$ (see Table 5). However, a Chi Square across Trial Type at 3 1/2 months showed that infants were more likely to receive More Happy ratings during matched happy trials than during other types of displays, $X^2(7)=15.33$, $p<.05$ (see Table 5).

Insert Table 5 Here

In addition to the More Happy / Less Happy measure, a more specific measure of infant facial affect was developed to examine the role of smiling in the other analyses of emotion expression. The occurrence of smiling during each trial was measured using a dichotomous variable, such that trials were scored according to whether or not the infant smiled while looking at the display area (Presence / Absence of Smiling). The analysis of Presence / Absence of Smiling was conducted similarly to that of the More Happy / Less Happy variable. Reliability estimates of the Presence / Absence of Smiling were computed using the same subsample of taped sessions as was used in the computation of reliability for the infant facial affect coding system. A Cohen's Kappa revealed a high agreement for the Presence / Absence of Smiling scores that resulted from these separate sets of ratings, k=.91 (95% confidence interval = $.83<k<.99$).

The Presence / Absence of Smiling scores were subjected to several Chi Square analyses to determine whether effects for this measure could further elucidate findings from the other analyses of infant affect. A Chi Square across the 4 Trial Types at 2 months revealed that infants smiled less than would be expected by chance across all trials at this age, $X^2(7)=24.33$, $p<.01$ (see Table 6). However, a Chi Square across Trial Type at 3 1/2 months revealed no significant differences, $X^2(7)=4.22$, $p<.8$ (see Table 6).

Insert Table 6 Here

In addition to the above analyses of infant affect, a fourth measure was used to determine if infants differed in the degree to which they seemed "interactive" across the various ages, conditions, and trial types. The reliability of this 9-point "interactiveness" scale was tested using the same methods as the other rating measures, however, another subsample of 9 recorded sessions (4 at 2 months, 5 at 4 months) served as a reliability comparison. A Pearson Product-Moment Correlation comparing the 2 sets of infant "interactiveness" ratings was significant, $r(36)=.782$, $p<.0001$.

Mean scores for each Trial Type from each session were computed for the 9-point infant "interactiveness" scale and subjected to a 2(Condition) X 2(Age) X 4(Trial Type) Mixed ANOVA. This analysis revealed a significant main effect for Age, $F(1,16)=8.93$, $p<.01$, which resulted from the tendency for infants to be rated as less "interactive" at 2 months (M=4.06, SD=1.58) than at 3 1/2 months (M=4.95, SD=1.31). In addition to this main effect, the analysis revealed a significant Age X Condition interaction, $F(1,16)=11.41$, $p<.01$. A Fisher's post-hoc test revealed 2 sources of this interaction, a significant difference between the "interactiveness" scores of 2-month olds ($M=3.73$, $SD=1.81$) and 3 1/2-month olds ($M=5.51$, $SD=1.29$) in the static condition and a significant difference between the "interactiveness" scores of infants in the static ($M=5.51$, $SD=1.29$) and dynamic conditions at 3 1/2 months ($M=4.25$, $SD=1.35$) (see Figure 3).

Insert Figure 3 Here

No other significant main effects or interactions were revealed in this analysis (see Table 7).

Insert Table 7 Here

Analysis of Questionnaire Data

Even though the attrition in this study was typical of perception research with very young infants, an additional attempt was made to account for the high attrition rate at 2 months by relating exclusion from the main study to individual differences in infants' response styles. The questionnaire which parents completed when they brought their 2-month-old infants to the testing session consisted of 8 of the original 24 items from the Infant Characteristics Questionnaire (Bates et al., 1979) and 6 added items that were designed to measure infants' experience and typical responses to face-to-face interaction. Fifty completed questionnaires were collected from the 51 infants who were tested at 2 months, because one infants' mother did not answer all 14 items.

Factor Analysis with oblique rotation was performed on the 50 completed questionnaires to reduce the data to a more meaningful set of variables. An oblique rotation was used because this method preserves the correlations between factors during an analysis. A Common Factor Analysis was used as an exploratory procedure, rather than a Component Analysis, because this statistic provides a more accurate representation of the structures that underlie smaller data sets (Snook & Gorsuch, 1989). The exploratory Factor Analysis revealed 3 factors with eigenvalues greater than one. A fourth factor with an eigenvalue of .79 was identified based on the standard regression coefficients and the conceptual relatedness of the items which suggested that, although its contribution to communality was smaller than the other 3, this fourth factor might be meaningful. The decision to include this fourth factor was based on the conclusions of Cliff (1988) who showed that the component scores of factors with eigenvalues less than unity are often reliable. Table 8 lists the factor loadings of each of the items on each of the 4 factors.

Insert Table 8 Here

The 4 factors that were identified reflected parents' perceptions of their infants' tendency to show a Negative Response to Novelty, Positive Response to Play, Positive Response to Face-to-Face Interaction, and Negative Affect. Negative Response to Novelty was comprised of items 1, 2, 5, and 6 which asked how the infant typically responded to a new person (1) or place (2), how easily he/she could be upset (5), and how easily he/she could be calmed when fussy (6). Positive Response to Play contained items 12 and 13 which asked how emotionally expressive (12) and excited (13) the infant became when others played with him/her. Positive Response to Face-to-Face Interaction was comprised of items 9 and 11 which asked how interested the infant was in human faces (9) and how attentive he/she was during face-to-face interaction. Negative Affect consisted of items 3, 7, and 8, which asked how the infant typically responded to sitting in an infant seat (3), how much he/she smiled and made happy noises (7), and what kind of mood he/she was generally in (8). Items 4, 10, and 14 were excluded from future analyses, because they did not show significant factor loadings on either of the factors.

Because the selection of factors by eigenvalues, regression coefficients, and conceptual relatedness does not indicate which factors will be reliable, the internal consistency of each of the 4 factors was evaluated further using a series of Cronbach Coefficient Alphas. Internal consistency, as measured by coefficient alpha, separates the variance within a questionnaire that is attributable to subjects from the variance that is attributable to an interaction between subjects and items (Cortina, 1993). This analysis revealed that including item 3 in Negative Affect lowered this factor's internal consistency, so only items 7 and 8 were used to indicate Negative Affect in the final analyses. All other factors showed coefficient alphas that were within the acceptable range. Factors that contained only 2 items had particularly high coefficient alphas considering the low number of items that comprised them. Table 9 shows the coefficient alphas of each factor, the coefficient alpha of this factor when individual items are deleted, and the correlation between items and factors.

Insert Table 9 Here

Individual scores for each of the resulting factors were derived by computing mean composite scores for each factor from the items that comprised it. These values were analyzed using a Hierarchical Regression Analysis with the 4 factors as predictors and infants' status of inclusion in the main study as the regressor. This analysis revealed that a 1 factor model, consisting of Negative Response to Novelty, predicted nearly 1/5 of the variance in the subject attrition at 2 months, R^2=.18. The other 3 factors did not contribute significantly to this prediction. Table 10 provides a more detailed account of the results of the regression analysis.

Insert Table 10 Here

Discussion

This study investigated the development of sensitivity to bimodal expressions of affect in early infancy. It was predicted that perception in 2-month-old infants would reflect a greater dependence on audition because this sense is more fully developed than vision in the first few postnatal months. That is, 2-month olds were expected to attend more to faces that were accompanied by happy voices, regardless of the emotion that was expressed by the face. Two face-movement conditions, dynamic and static, were also included to explore the possibility that facial gestures might facilitate young infants' recognition that some face-voice combinations contained matching affective expressions. To the extent that dynamic faces encouraged 2-month olds to attend more closely to internal features of the face, it was hypothesized that this condition would result in increased attention to affectively matched displays (e.g., SFSV, HFHV). By 3 1/2 months of age, it was predicted that infants would no longer demonstrate auditory dominance in their responses so that they would attend more to affectively matched face-voice combinations in both the dynamic and static conditions.

Separate hypotheses of infant emotion expression were also proposed in this study. Infant affect was hypothesized to correspond to infant perception, such that more positive emotion expression was predicted in response to stimuli that infants perceived as "happy" and less positive to stimuli that infants perceived as "sad". Older infants were expected to show more positive affect than younger infants. These predictions differ considerably from the actual findings of the study.

Infant Attention

The two measures of infant attention in this study, Total Looking Time and Average Look Length, failed to provide evidence that infants attended differentially to the 4 face-voice combinations under either face-movement condition at either age. Moreover, it was found that across the 2 ages studied, infants looked longer at static faces, as measured by Total Looking Time, than at dynamic faces. This result was both unexpected and perplexing because the prediction that dynamic faces would facilitate perception at 2 months had been based on the assumption that dynamic faces would capture the attention of young infants more effectively than static ones. Instead of increasing infants' attention, however, dynamic faces appear to have reduced the total amount of time that infants spent looking at visual displays. Thus, either static faces accompanied by voices were more interesting to young infants than had originally been suggested, or some quality of the dynamic face-voice displays discouraged infant attention.

One possible explanation for infants' increased attention to static faces is that the temporal asynchrony of the face and voice in the dynamic condition made it more difficult for the young infants to fixate these displays. As was previously mentioned, the voice was intentionally dubbed onto tapes of dynamic faces so that the facial gestures were not timed to correspond to the voice. This temporal asynchrony between faces and voices in the dynamic condition was necessary because it would have been difficult to artificially produce temporally synchronous face-voice combinations which were not affectively matched (e.g., SFHV, HFSV). Thus, the temporal asynchrony across all dynamic displays insured that infants would respond to these stimuli based on amodal affective information rather than the presence or absence of temporal synchrony.

The basis for most of the current understanding of infant perception of temporal synchrony between visual and auditory events has been provided by Spelke (1976, 1979, 1981). Across a wide range of phenomena, her work has demonstrated that when presented with 2 films side-by-side, infants as young as 4 months look longer at the film that corresponds to a temporally synchronous soundtrack. Whereas infants in the dynamic condition in the present study were only shown asynchronous face-voice combinations, those in Spelke's research have been given a choice of visual displays at which they may look. Thus, Spelke's dual-screen method can answer the question of whether infants prefer to look at visual displays that are synchronous with the sounds they hear, but it is less well suited for studying infants' reactions to asynchronous bimodal events. In other words, it can be ascertained that infants prefer synchronous bimodal events over asynchronous ones from this work, but it is unclear whether infants attend less to asynchronous displays because they are aversive or simply because they are less interesting than synchronous stimuli.

A clearer understanding of infants' reactions to asynchronous auditory and visual events can be gained from Dodd's (1979) investigation of infants' responses to alternating synchronous and asynchronous face-voice displays. In this study, 10- to 16-week-old infants viewed the experimenter's face through a glass window in a sound-proof cubicle while her voice was played either synchronously or asynchronously (delayed by 400 msecs) on a loudspeaker. The experimenter attempted to maintain eye-contact with the infant while reciting nursery rhymes throughout the session. The results of this study showed that young infants looked at the experimenter's face less when her voice was played asynchronously than when it was played synchronously. In addition, Dodd (1979) provided anecdotal reports that several infants showed distress as well as inattention during asynchronous trials. These findings suggest that very young infants like those in the present study may find temporally asynchronous voices and moving faces disturbing.

To the extent that temporal asynchrony influenced the responding of the 2- and 3 1/2-month olds in this study, the differences in infants' attention to dynamic and static displays may provide additional evidence that sensitivity to temporal relations exists prior to the fourth postnatal month. However, caution must be advised when interpreting this result for several reasons. First, Total Looking Time was the only measure that differentiated infants' attention to static and dynamic displays. The Average Look Length, or the Total Looking Time divided by the number of looks, did not reveal this same effect for face-movement condition. The lack of correspondence between these two measures of infant attention occurred because the total amount of time that an infant spent fixating the display was not related to the number of individual looks which comprised this measure. That is, one infant who looked for 50 secs at a particular face-voice combination might show a single long look of this duration, whereas this same Total Looking Time for a second infant might consist of as many as 12 individual fixations. Further, the difference in the mean Total Looking Times for the static and dynamic conditions is actually very small

(3.32 secs), despite the statistical significance of this finding. Thus, the degree to which infants actually attended more to static than to dynamic faces that were accompanied by voices is minimal, despite the statistical significance of this effect.

In addition to the unexpected effect of face-movement condition, another perplexing result was the lack of differences in infants' attention to the various face-voice combinations. Several possible reasons are suggested to explain infants' undifferentiated responding in the present study: 1) infants may have been unable to discriminate the face-voice combinations, 2) the face-voice combinations may have all been equally uninteresting to young infants so that they failed to attend differentially to them, 3) the stimuli may all have been highly salient for young infants, causing them to attend similarly across all trials, and 4) infants younger than 4 1/2 months may not attend differentially to face-voice stimuli when tested in this manner. Each one of these possible explanations can be evaluated with respect to the present study and other research in infant perception.

Whether infants were able to discriminate the face-voice combinations is difficult to address, given the results of this study. However, infants as young as 3 months have been found to discriminate unmoving happy and sad facial expressions (Young-Browne et al., 1977) and to be aware of the relations between voices and static faces that express these emotions (Walker-Andrews & Grolnick, 1983). Thus, it seems reasonable to suggest that at least by 3 1/2 months infants in the present study could discriminate the 4 different displays in the static condition. Further research would be required in order to ascertain whether 2-month-old infants could discriminate these face-voice combinations and whether dynamic faces reduce the ability of young infants to make such distinctions. Conclusions about the effects of face movement on very young infants' abilities to discriminate bimodal affective stimuli could be accomplished by the use of an infant-controlled habituation procedure which is designed to test discrimination abilities.

A second reason that infants in the present study may have attended similarly to the displays is that the face-voice combinations were equally uninteresting to them. This explanation is not supported by the current literature which advocates the high salience of faces and voices for young infants. Additionally, the infants in this study looked at dynamic faces for an average of 74% of the trial time and at static faces for an average of 79% of the trial time. These figures indicate that infants found the displays interesting enough in the present study to continue looking at them for the much of the time that they were presented.

However, it is also possible that the long time infants spent attending to the stimuli was, in part, a result of the barren interior of the apparatus. That is, the absence of any other interesting spectacle compelled infants to look at the displays for the majority of the trial time. This explanation is supported by the finding that 47% of infants at 2 months and 90% of infants at 3 1/2 months increased their number of visual fixations from the first to the second half of the 8-trial session. Thus, after experiencing several face-voice combinations infants tended to look away from the screen more frequently on subsequent trials, but finding no other spectacle to attend to, they continued to look back at the display. This pattern of looking could be interpreted as evidence that the stimuli were not sufficiently interesting to infants after several presentations but that the barrenness of the apparatus compelled infants to continue attending to them. This study, like other research in infant perception, sought to isolate the stimuli that infants experienced so that other distractions did not influence the attention of young infants. However, perhaps the introduction of alternative visual spectacles during trials would better approximate circumstances that infants encounter in their natural environments.

Conversely, the third explanation, that the face-voice stimuli used in this study may have been so highly salient to the infants that they attended to all 4 combinations equally, may also explain the lack of differences in attention. Facial stimuli alone have been shown to captivate infants at very early ages, and the high salience of faces is further increased when such displays are accompanied by a voice. In particular, Pegg and her colleagues (1992) found that 6- to 8-week-old infants did not attend differentially to videotapes of a man and woman talking, even though infants within this age range could discriminate the soundtracks of these displays when they were presented without faces. In another study, Walker-Andrews and her colleagues (1991) demonstrated a similar failure of 3 1/2 month-old infants to attend differentially to various face-voice combinations. These results suggest that infants younger than 4 months may find the combination of a face and a voice so interesting that the specific information of such displays becomes secondary. If this is the reason for the results of the present study, it should follow that 2- and 3 1/2-month-old infants will attend differentially to the various faces and voices when they are not presented bimodally.

However, the usually high salience of face-voice combinations to young infants may be enhanced even further by the type of voices that were used as stimuli in this study. Voices in the present study were all representative of female ID speech which infants prefer over AD speech throughout the first few postnatal months (Cooper & Aslin, 1990; Fernald, 1985; Pegg et al., 1992; Werker & McLeod, 1989). Other than the present investigation, only 2 other studies have presented face-voice displays to young infants in which the vocal component was specifically identified as ID speech (Pegg et al., 1992; Werker & McLeod, 1989), and these studies did not compare infants' responses to speech that differed in its affective content. Another study that used only voice stimuli provided evidence that 4-month olds attend differentially to ID speech which communicates approval and prohibition (Fernald, 1989). Still, it is not known whether the younger infants in the present study would have attended differentially to happy and sad vocal expressions had they been presented in the absence of faces. In order to determine the effect of speech type (ID or AD) on young infants' perception of affect, infants responses to the happy and sad voices in this study could be compared to AD vocal expressions that express the same emotions.

The last explanation, that the methods of this study may be less effective for eliciting differential attention to voice-face stimuli in very young infants is also feasible. A review of the current literature shows that the only procedure that has been successful in demonstrating differences in attention to bimodal affective stimuli in infants younger than 4 months is infant-controlled habituation (Pegg et al., 1992; Walker-Andrews & Grolnick, 1983). At the time this study was conducted, no evidence existed to suggest that this method might not be appropriate for younger infants. However, in a recent study this method failed to demonstrate differentiated responding to face-voice displays in 6- to 8-week-old infants, despite the ability of infants within this age range to discriminate the vocal components of these displays (Pegg et al., 1992). Perhaps, when very young infants are presented with a series of face-voice displays in a fixed-length trial preference procedure they attend to each display similarly, even though they are capable of differentiating the various combinations, and even though they may prefer some over others.

An alternative method that has been used to demonstrate infants' bimodal perception of affect is the simultaneous presentation or dual-screen matching procedure. This method was adapted from Spelke's (1976, 1979, 1981) temporal synchrony work in which 2 screens positioned approximately 8 cm apart are used to present visual stimuli while a centrally located speaker presents sound that corresponds to one of the displays. The trials in this method are of fixed duration and are typically 2 mins in length. Using this procedure, Walker (1982) has demonstrated that infants as young as 5 months look longer at faces that match the affect of a voice that is being played even when the voice and moving face are temporally asynchronous.

Interestingly, a similar study that examined whether infants preferred faces and voices that were matched for the gender of a speaker found that although 6-month-old infants preferred matching stimuli, 4-month olds only showed this effect during the last few trials, and 3 1/2-month olds did not prefer matching faces and voices at any time in the experiment (Walker-Andrews et al., 1991). To the extent that the results of this study can serve as an indicator of the effectiveness of the simultaneous presentation matching procedure for use with younger infants, it would seem that prior to 4 months of age infants are not capable of demonstrating their understanding of the relations between faces and voices under such conditions.

Several aspects of the dual-screen matching procedure suggest reasons that it may be inappropriate for use with very young infants. In particular, the use of 2 separate screens is necessary to present a choice of visual stimuli that infants can match with the sounds being played, but infants younger than 3 months may not be capable of showing preferences for matched visual and auditory events when they are presented in this way. In addition, the absence of any contingency between this procedure and the infant's behavior may also contribute to its ineffectiveness as a test of very young infants' understanding of bimodal relations. Similar limitations of other procedures probably underlie the wide-spread use of infant-controlled procedures (e.g., preference, habituation) in research of very young infants, because such methods are conducive to the presentation of stimuli in single modalities and because they rely on contingent responding in infants. The use of infant-controlled procedures has already been suggested as a method for further investigating the responses of very young infants to the faces, voices, and face-voice combinations in this study.

Infant Affect and "Interactiveness"

Whereas measures of infant attention in this study failed to support the original hypotheses, further investigation of other infant social behaviors showed that infants did respond differently to the static and dynamic conditions and to the bimodal affective stimuli. The original hypotheses predicted that infant affect should correspond to infant attention during various face-voice combinations, but the lack of systematic differences in attention precluded this relationship between affect and attention. Nevertheless, measures of infant affect and "interactiveness" alone provided support for several of the predictions.

Infant affect, as measured by the More Happy / Less Happy ratings and by the infant facial affect scale, confirmed the hypothesis that infants would respond with more positive affect to happy displays than to sad ones. In particular, 3 1/2-month old infants were rated as More Happy on a greater number of trials that showed matched happy stimuli than on any of the other trial types. This finding suggests that at least by 3 1/2 months infants responded to the combination of a happy face and a happy voice with more positive affect than to face-voice stimuli that contained sad elements. Additionally, the analysis of infant facial affect revealed a marginal effect that was characterized by less positive facial expression during matched sad displays than to the other 3 trial types at both ages. Because the youngest infants in this study showed differences in affective responding only to the matched sad stimuli, this finding suggests that, at least where affective measures are concerned, auditory dominance does not characterize infant responses at this age. Apparently, infant affect at both ages was influenced by the combination of auditory and visual aspects of the displays, rather than by a single modality.

A subsequent analysis on whether or not the Presence / Absence of Smiling could underlie these different affective responses was also conducted. However, this measure showed that infants were no more likely to smile during HFHV trials at 3 1/2 months than during other trials and that they were no less likely to smile during SFSV trials at either age. Thus, the results of the More / Less Happy measure and the infant facial affect ratings cannot be explained by the occurrence of infant smiling. Possibly, affective behaviors other than smiling, such as eye brightening, frowning, or changes in motor activity, contributed to these effects. Further analyses of such specific affective behaviors could provide a more detailed description of the behaviors that underlie these findings.

The hypothesis that older infants would show more positive affect than younger infants overall was also supported in this study. In particular, the analysis of infant facial affect showed that infants were rated as showing more positive expressions across all conditions and trials at 3 1/2 months than at 2 months. The analysis of the Presence / Absence of Smiling suggested that this result occurred because infants smiled less at the earlier age. Interestingly, the More Happy / Less Happy ratings did not reiterate this effect of age. This lack of correspondence between measures can be explained by the fact that raters who used the More Happy / Less Happy scale were asked to rate each session according to the range of affect of that particular infant during the session. Because of these instructions, separate, but reliable, criteria may have emerged for rating 2- and 3 1/2-month-old infants. That is, 2-month olds probably received More Happy ratings when they looked attentive but did not smile and Less Happy ratings when they grimaced, and 3 1/2-month olds received More Happy ratings when they smiled and Less Happy ratings when they attended but did not smile. In this way, having raters base their judgements on a particular session, rather than on a standard criterion, masked the age differences in infant emotion expression.

In addition to the measures of infant affect, a scale designed to assess how "interactive" an infant appeared in response to the stimuli was also used. Infant "interactiveness" was hypothesized to show effects for age and display type that were similar to those predicted for infant affect. However, this measure deviated considerably from these expectations. Infants who viewed static faces accompanied by voices were rated as more "interactive" at 3 1/2 months than at 2 months, but infants in the dynamic condition were rated similarly across the 2 ages for this measure.

Although differences in infant attention to static and dynamic displays were questionable, infants' levels of "interactiveness" did distinguish their responses to these 2 conditions. In particular, some aspect of the dynamic face-voice stimuli in this study discouraged "interactive" behavior in 3 1/2-month-old infants. This same effect was not demonstrated in 2-month olds because at this age infants rarely showed high levels of "interactiveness". Thus, older infants who may have been more capable of demonstrating high levels of "interactiveness" only did so in response to voices and static faces. Whether 2-month olds perceived static and dynamic displays differently cannot be determined from this measure. However, by 3 1/2 months, infants in this study did respond differently to the 2 face-movement conditions.

Several suggestions can be made as to which quality of the dynamic displays contributed to this reduction in infants' "interactiveness" at 3 1/2 months. As was proposed before, the temporal asynchrony of the dynamic stimuli may have caused infants in this condition to look less at the displays, and less attention may have been scored as low "interactiveness". A second possibility, however, is that 3 1/2-month-old infants were more "interactive" in the static condition because they were trying to elicit a response from these faces. Alternatively, the combination of activity and non-contingency of the dynamic displays invoked a response in these infants that was more similar to the behavior of infants who are observing an event without attempting to affect it. This interpretation is supported by the finding that 60% of the trials at 3 1/2 months in the static condition received "interactiveness" scores that exceeded 5 points, whereas only 28% of dynamic trials at this age showed such high ratings. Infants who viewed static displays not only received higher scores at 3 1/2 months, they were also more likely to demonstrate a pattern of responding that was characterized by decreasing interactiveness during the last few trials. At 3 1/2 months, 78% of trials in the static condition showed this pattern compared to only 33% of those in the dynamic condition. The majority of 3 1/2-month-olds who viewed dynamic displays maintained low levels of "interactiveness". These distinct patterns of responding suggest that 3 1/2-month olds in the static condition decreased their high levels of "interactiveness" when it became apparent that the static face was unresponsive, whereas those in the dynamic condition behaved like passive onlookers throughout the session. Further research is needed to examine the effects of contingent and non-contingent face-voice combinations on young infants' behavior.

Combining Measures of Affect and Attention

Whereas research in parent-infant social interaction has long recognized the importance of combining measures of infant affect and attention (e.g., Fogel, 1977; Stern, 1974a), studies of infant perception of social events have only recently begun to examine infants' affective responses to multimodal stimuli (e.g., Fernald, 1989; Pegg et al., 1992; Werker & McLeod, 1989). Several investigators have recently suggested that the term, "preference", which has permeated research in infant perception for several decades, may require further definition (e.g., Cooper & Aslin, 1990; Fernald, 1985). These researchers maintain that the finding that infants show longer visual fixations in response to particular stimuli can be interpreted as a "preference" for those stimuli over others in the sense that infants appear more interested in those events. However, such attentional "preferences" may not indicate that infants "like" or "enjoy" certain stimuli more than others. An even more complicated view of infant "preferences" emerges when the many different combinations of attention and affective responses are considered. Figure 4 represents the potential complexity of the relations between infant affect and attention in a 2 (Attention: more, less) X 3 (Affect: positive, neutral, negative) model. In this model, the levels of attention, more and less, represent relative amounts of attention within studies. That is, had infants in the present study looked longer at matched happy displays than to other face-voice combinations, their attention to HFHV displays would have been termed "more", and their attention to other types of displays would have been termed "less".

Insert Figure 4 Here

The complexity of infant responding that emerges when both attention and affect are considered has not been realized in studies of infant perception to date. For example, the 2 studies that successfully differentiated infant responses using measures of attention and affect have only reported 2 types of combinations, more attention accompanied by positive affect and less attention accompanied by neutral affect (Fernald, 1989; Werker & McLeod, 1989). These findings are consistent with research on infants' responses to their mothers' behavior which has shown that when infants display positive emotion they usually face their mothers, but when they display negative emotion they usually avert their gazes (Haviland & Lelwica, 1982; Stern, 1974a; Symons et al., 1989; Tronick et al., 1975). According to several investigators, the first of these combinations probably indicates that the infant is interested and likes his/her mother's social display, while the second suggests that the infant finds his/her mother's behavior to be aversive (Stern, 1974a; Tronick et al., 1975). The findings that infants respond to their mothers' happy expressions with increased visual fixation and smiling (Haviland & Lelwica, 1982) but that an unresponsive still-faced mother elicits an aversive reaction (Tronick et al., 1975) further support these interpretations. Although it is possible that these 2 combinations of infant attention and affect are among the more common types of displays, their frequent occurrence does not preclude the existence of other combinations.

To date, no work has recognized the other combinations of infant affect and attention in the proposed model as a system of distinct categories of responding. Nevertheless, careful scrutiny of other work suggests that they have been observed. For example, the combination of positive affect and less attention can be used to characterize older infants' behavior during social referencing. During social referencing, infants are absorbed in another activity, so their attention to a parent or caregiver is less than it would be if they were engaged in play with the adult (Feinman & Lewis, 1983; Malatesta & Izard, 1984). Nevertheless, an infant's brief glances to the familiar adult during social referencing are often accompanied by smiles. The combination of positive affect and less attention place the infant's response to the adult within a framework that allows infant behavior to be examined systematically according to these 2 dimensions.

In addition to this type of response, infants may show differences in attention that are accompanied by neutral affect. Very young infants who participate in perception research may be particularly prone to these types of responses because they display a preponderance of neutral affect under these conditions (Pegg et al., 1992). For example, if 2-month-old infants in the present study can be said to have attended more to static than to dynamic displays, their similarly neutral affect to these 2 types of stimuli would place them in the 2 neutral affect categories. Interestingly, other researchers have reported that 4-month-old infants differentiate their attention while showing neutral affect to a toy that moves contingently in response to their activity (Leegerstee, Pomerleau, Malcuit, & Feider, 1987; Leegerstee, Corter, & Kienapple, 1990). These investigators have suggested that older infants who have the capacity to express a wide range of emotions restrict their affective responses to inanimate objects because they are able to differentiate social and non-social stimuli.

Another response that seems to be exclusive to very young infants is prolonged attention accompanied by negative affect. This type of response probably occurs when young infants who have reached a point of exhaustion after several trials begin to grimace and fuss while they are still looking at the stimulus. Unlike older infants who would turn away from the display while showing negative affect, very young infants continue to look at the stimulus which may result in more attention to this display than others. Because crying typically follows this combination of affect and attention, examples of such behavior are likely to be excluded from most studies, thereby making it difficult to estimate the prevalence of this last type of response. This lack of documentation of the more-attention-negative-affect classification makes the existence of this category more tenuous than the other 5 combinations. Still, the proposed model demonstrates such a wide variety of reactions to events, even for very young infants, that current uses of the term "preference" probably should be refined to include both attention and affect.

Because few studies of infant perception have examined affective responding before the third postnatal month, the use of such measures with very young infants has not been perfected. Indeed, Pegg and her colleagues (1992) have suggested that emotion expression variables may even be inappropriate for use with very young infants because they do not display a wide range of affect. However, as the present study has demonstrated, the use of measures that detect subtle positive expressions of emotion, such as eye brightening and eyebrow raising, may reveal differences in affective responding to videotaped faces and voices in infants as young as 2 months. Other studies confirm the importance of examining behaviors in very young infants that might be overlooked as expressions of emotion in older infants or adults. For example, non-smile mouth movements (Haviland & Lelwica, 1982) and hand and arm movements (Legerstee et al., 1990) have been shown to distinguish infants' responses to various social stimuli before the third postnatal month, and limb and trunk movement and orientation have been used to differentiate the responses of 4-month olds to facial expressions of emotion (Serrano, Iglesias, & Loeches, 1991). Further research is needed to determine whether very young infants show differentiated responding to prerecorded stimuli on any of these measures.

Because behavioral measures of young infants' affect deviate considerably from traditional indicators of emotion, such as smiling, it may be difficult to associate these early responses with "internal feeling states". However, psychophysiological methods have been used to investigate this correspondence between the internal states and external expressions of young infants (Fox, 1991). In particular, Fox and Davidson (1986) have demonstrated that discrete changes in the facial expressions of newborns correspond to changes in left-hemisphere activation, as measured by an electroencephalogram (EEG). Such methods could be used to describe the internal states of infants who show expressive behaviors that have not been investigated as thoroughly as the more well known facial expressions (e.g. frowning, smiling). In this way, young infants' subtle behavioral responses could be better understood as indicators of affect, and discussions of early infant perception could be expanded to include affective responses.

Contributions of Individual Differences to Attrition

The findings of the present study provided evidence that individual differences in infants' characteristic patterns of responding may influence subject attrition in infant perception research. In particular, infants who were rated by parents as showing greater tendencies to respond negatively to novel situations were more likely to fail to complete the testing session at 2 months than other infants. Whereas other researchers have explained high attrition rates at 2 months by the increase in infant fussiness that characterizes this period in early infancy (Sullivan & Horowitz, 1983), the present study suggests that variability among 2-month-old infants may also contribute to this phenomenon. Because parents only rated their infants during the 2 month visit, the consistency of these characteristics across ages cannot be determined. Additional research is needed to ascertain whether even transient individual differences in infants' response styles are associated with differences in infant perception. However, until such evidence is provided research in infant perception will probably continue to be dominated by a normative orientation.

References

Ambrose, J. A. (1961). The development of the smiling response in early infancy. In B. M. Foss (Ed.), _Determinants of Infant Behavior_, (pp. 179-201). New York: John Wiley & Sons.

Ambrose, J. A. (1963). The concept of a critical period for the development of social responsiveness in early human infancy. In B. M. Foss (Ed.), _Determinants of Infant Behavior, II_, (pp.201-226). New York: John Wiley & Sons.

Aslin, R. N. (1987). Visual and auditory development in infancy. In J. D. Osofsky (Ed.), _Handbook of Infant Development, Second Edition_, (pp. 5-97). New York: John Wiley & Sons.

Barerra, M. E. & Maurer, D. (1981). The perception of facial expressions by the three-month old. _Child Development_, _52_, 203-206.

Bates, J. E., Freeland, C. B., & Lounsbury, M. L. (1979). Measurement of infant difficultness. _Child Development_, _50_, 794-803.

Bertenthal, B. I., Profitt, D. R., Spetner, N. B., & Thomas, M. A. (1985). The development of infant sensitivity to biomechanical motions. _Child Development_, _56_, 531-543.

Brazelton, T. B. (1983). Precursors for the development of emotions in early infancy. In R. Plutchik & H. Kellerman (Eds.), Emotion: Theory, Research, and Experience, (pp. 35-55). New York: Academic Press.

Brazelton, T. B., Koslowski, B., & Main, M. (1974). The origins of reciprocity: The early mother-infant interaction. In M. Lewis & M. Rosenblum (Eds.), The Effect of the Infant on its Caregiver, (pp. 49-76). New York: John Wiley & Sons.

Bronson, G. W. (1982). Structure, status, and characteristics of the nervous system at birth. In P. Stratton (Ed.), Psychobiology of the Human Newborn, (pp. 99-118). New York: Wiley.

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

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

Carpenter, G. (1974). Visual regard of moving and stationary faces in early infancy. Merrill-Palmer Quarterly, 20, 181-194.

Cliff, N. (1988). The eigenvalues-greater-than-one rule and the reliability of components. Psychological Bulletin, 103, 276-279.

Cohn, J. F. & Tronick, E. Z. (1983). Three-month-old infants' reaction to simulated maternal depression. Child Development, 54, 185-193.

Columbo, J. & Bundy, R. S. (1981). A method for the measurement of infant auditory selectivity. Infant Behavior and Development, 4, 219-223.

Cooper, R. P. & Aslin, R. N. (1990). Preference for infant-directed speech in the first month after birth. Child Development, 61, 1584-1595.

Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. Journal of Applied Psychology, 78, 98-104.

Crnic, K. A., Ragozin, A. S., Greenberg, M. T., Robinson, N. M., & Basham, R. B. (1983). Social interaction and developmental competence of preterm and full-term infants during the first year of life. Child Development, 54, 1199-1210.

DeCasper, A. J. & Fifer, W. P. (1980). Of human bonding: Newborns prefer their mothers' voices. Science, 208, 1174-1176.

Dent, C. H. (1990). An ecological approach to language development: An alternative functionalism. Developmental Psychobiology, 23, 679-703.

Dodd, B. (1979). Lip reading in infants: Attention to speech presented in- and out-of-synchrony. Cognitive Psychology, 11, 478-484.

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

Emde, R. N. (1980). Levels of meaning for infant emotions: A biosocial view. In W. A. Collins (Ed.), Development of Cognition, Affect, and Social Relations: Minnesota Symposia on Child Psychology, Vol 13. Hillsdale, NJ: Lawrence Erlbaum and Associates.

Emde, R. N. & Gaensbauer, T. (1981). Some emerging models of emotion in human infancy. In K. Immelman, G. Barlow, L. Petrinovich, & M. Main (Eds.), Behavioral Development, (pp. 569-588). Cambridge, England: Cambridge University Press.

Emde, R. N., Gaensbauer, T., & Harmon, R. J. (1976). Emotional expression in infancy: A biobehavioral study. Psychological Issues, 10(1), Monograph 37.

Feinman, S. & Lewis, M. (1983). Social referencing at ten months: A second-order effect on infants' responses to strangers. Child Development, 54, 878-887.

Fernald, A. (1984). The perceptual and affective salience of mothers' speech to infants. In L. Feagans, C. Garvey, & R. Golinkoff (Eds.), The Origins and Growth of Communication, (pp. 5-29). Norwood, NJ: Ablex.

Fernald, A. (1985). Four-month-old infants prefer to listen to motherese. Infant Behavior and Development, 8, 181-195.

Fernald, A. (1989). Intonation and communicative intent in mothers' speech to infants: Is the melody the message? Child Development, 60, 1497-1510.

Fernald, A. (in press). Approval and disapproval: Infant responsiveness to vocal affect in familiar and unfamiliar languages. Child Development.

Fernald, A. & Simon, T. (1984). Expanded intonation contours in mothers' speech to newborns. Developmental Psychology, 20, 104-113.

Fernald, A., Taeschner, T., Dunn, J., Papousek, M., de Boysson-Bardies, B., & Fukui, I. (1989). A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants. Journal of Child Language, 16, 477-501.

Field, T. M. (1981). Infant arousal, attention, and affect during early interactions. In L. P. Lipsitt & C. Rovee-Collier (Eds.), Advances in Infancy Research, Vol. 1, (pp. 57-100). Norwood, NJ: Ablex.

Field, T. M., Woodson, R., Greenberg, R., & Cohen, D. (1982). Discrimination and imitation of facial expressions by neonates. Science, 281, 179-181.

Fifer, W. P. & Moon, C. (in press). Early voice discrimination. In C. von Euler (Ed.), The Neurobiology of Early Infant Behavior, Wenner-Gren International Symposium Series, Vol 45. New York: Stockton Press.

Fogel, A. (1977). Temporal organization in mother infant face-to-face interaction. In H. R. Schaffer (Ed.), Studies in Mother-Infant Interaction, (pp. 119-152). New York: Academic Press.

Fogel, A. & Thelen, E. (1987). Development of early expressive and communicative action: Reinterpreting the evidence from a dynamic systems perspective. Developmental Psychology, 23(6), 747-761.

Fox, N. A. (1991). If it's not left, it's right: Electroencephalograph asymmetry and the development of emotion. American Psychologist, 46, 863-872.

Fox, N. A. & Davidson, R. J. (1986). Taste-elicited changes in facial signs of emotion and the asymmetry of brain electrical activity in human newborns. Neuropsychologia, 24, 417-422.

Garnica, O. K. (1977). Some prosodic and paralinguistic features of speech to young children. In C. E. Snow and C. A. Ferguson (Eds.), Talking to Children, (pp. 63-88). Cambridge, England: Cambridge University Press.

Gibson, E. J., Owsley, C. J., Walker, A., & Megaw-Nyce, J. (1979). Development of the perception of invariants: Substance and shape. Perception, 8, 609-619.

Glenn, S. M. & Cunningham, C. C. (1983). What do babies listen to most? A developmental study of auditory preferences in nonhandicapped infants and infants with Down's syndrome. Journal of Child Psychology and Child Psychiatry, 23, 319-327.

Gottlieb, G. (1971). Ontogenesis of sensory function in birds and mammals. In E. Tobach, L. R. Aronson, & E. Shaw (Eds.), The Biopsychology of Development, (pp. 67-126). New York: Academic Press.

Grieser, D. L. & Kuhl, P. K. (1988). Maternal speech to infants in a tonal language: Support for universal prosodic features in motherese. Developmental Psychology, 24, 14-20.

Haith, M. M., Bergman, T., & Moore, M. (1977). Eye contact and face scanning in early infancy. Science, 198, 853-855.

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

Heimann, M. (1989). Neonatal imitation, gaze aversion, and mother-infant interaction. Infant Behavior and Development, 12, 495-505.

Isabella, R. A., Belsky, J., & von Eye, A. (1989). Origins of infant-mother attachment: An examination of interactional synchrony during the infant's first year. Developmental Psychology, 25(1), 12-21.

Izard, C. E. (1971). The Face of Emotion. New York: Appleton-Century-Crofts.

Izard, C. E. (1977). Human Emotions. New York: Plenum.

Kaufman, R. & Kaufman, F. (1980). The face schema in 3- and 4-month-old infants: The role of dynamic properties of the face. Infant Behavior and Development, 3, 331-339.

Kuhl, P. K. & Meltzoff, A. N. (1984). The intermodal representation of speech in infants. Infant Behavior and Development, 7, 361-381.

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

Leegerstee, M., Corter, C., & Kienapple, K. (1990). Hand, arm, and facial actions of young infants to a social and nonsocial stimulus. Child Development, 61, 774-784.

Leegerstee, M., Pomerleau, A., Malcuit, G., & Feider, H. (1987). The development of infants' responses to people and a doll: Implications for research in communication. Infant Behavior and Development, 10, 81-95.

Lester, B. M., Hoffman, J., & Brazelton, T. B. (1985). The rhythmic structure of mother-infant interaction in term and preterm infants. Child Development, 56, 15-27.

Lewkowicz, D. J. (1988a). Sensory dominance in infants: 1. Six-month-old infants' response to auditory-visual compounds. Developmental Psychology, 24, 155-171.

Lewkowicz, D. J. (1988b). Sensory dominance in infants: 2. Ten-month-old infants' response to auditory-visual compounds. Developmental Psychology, 24, 172-182.

Malatesta, C. Z. & Haviland, J. M. (1982). Learning display rules: The socialization of emotion expression in infancy. Child Development, 53, 991-1003.

Malatesta, C. Z. & Izard, C. E. (1984). The ontogenesis of human social signals: From biological imperative to symbol utilization. In N. A. Fox and R. J. Davidson (Eds.), The Psychobiology of Affective Development, (pp. 161-206). Hillsdale, NJ: Lawrence Erlbaum and Associates.

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

McLeod, P. J. (April, 1991). Sequential dependencies in mother-infant interactions. Paper presented at the Biennial Meeting of the Society for Research in Child Development, Seattle, WA.

Mehler, J., Bertoncini, J., Barriere, M., & Jassik-Gerschenfeld, D. (1978). Infant recognition of mother's voice. Perception, 7, 491-497.

Meltzoff, A. N. & Moore, M. K. (1977). Facial and manual imitation by human neonates. Science, 198, 75-78.

Nelson, C. A. & Horowitz, F. D. (1983). The perception of facial expressions and stimulus motion by 2- and 5-month-old infants using holographic stimuli. Child Development, 54, 868-877.

Papousek, M., Papousek, H., & Bornstein, M. (1985). The naturalistic vocal environment of young infants: On the significance of homogeneity and variability in parental speech. In T. M. Field & N. A. Fox (Eds.), Social Perception of Infants, (pp. 269-297). Norwood, NJ: Ablex.

Pegg, J. E., Werker, J. F., & McLeod, P. J. (1992). Preference for infant-directed over adult-directed speech: Evidence from 7-week-old infants. Infant Behavior and Development, 15, 325-346.

Polak, P. R., Emde, R. N., & Spitz, R. A. (1964). The smiling response II: Visual discrimination and the onset of depth perception. The Journal of Nervous and Mental Disease, 139(5), 407-415.

Posner, M. I. & Peterson, S. E. (1990). The attention system of the human brain. Annual Review of Neuroscience, 13, 25-42.

Serrano, J. M., Iglesias, J., & Loeches, A. (November,1991). Visual fixation and motor-expressive response to happiness, anger, and neutral facial expressions in infants. Poster presented at the 24th annual meeting of the International Society for Developmental Psychobiology. New Orleans, LA.

Shapiro, B., Haith, M. M., Campos, J. J., Bertenthal, B. I., & Hazen, C. (1983). Motion enhances object perception for infants. Paper presented at the meeting of the Psychonomic Society, San Diego, CA.

Slater, A., Morison, V., Town, C., & Rose, D. (1985). Movement perception and identity constancy in the newborn baby. British Journal of Developmental Psychology, 3, 211-220.

Snook, S. C. & Gorsuch, R. L. (1989). Component Analysis versus Common Factor Analysis: A Monte Carlo study. Psychological Bulletin, 106, 149-154.

Spelke, E. S. (1976). Infants' intermodal perception of events. Cognition, 8, 53-60.

Spelke, E. S. (1979). Perceiving bimodally specified events in infancy. Developmental Psychology, 15, 626-636.

Spelke, E. S. (1981). The infant's acquisition of knowledge of bimodally specified events. Journal of Experimental Child Psychology, 31, 279-299.

Spelke, E. S. (1985). Perception of unity, persistence, and identity: Thoughts on infants' perceptions of objects. In J. Mehler & R. Fox (Eds.), Neonate Cognition: Beyond the Booming Buzzing Confusion, (pp. 89-113). Hillsdale, NJ: Erlbaum.

Spitz, R. A. & Wolf, K. M. (1946). The smiling response: A contribution to the ontogenesis of social relations. Genetic Psychology Monographs, 34, 57-125.

Sroufe, L. A. (1979). Socioemotional development. In J. Osofsky (Ed.), Handbook of Infant Development, (pp. 462-513). New York: John Wiley & Sons.

Stern, D. N. (1974a). Mother and infant at play: The dyadic interaction involving facial, vocal, and gaze behaviors. In M. Lewis & L. A. Rosenblum (Eds.), The Effect of the Infant on its Caregiver, (pp. 187-213). New York: John Wiley & Sons.

Stern, D. N. (1974b). The goal and structure of mother-infant play. Journal of the American Academy of Child Psychiatry, 13, 402-421.

Stern, D. N., Beebe, B., Jaffe, J., & Bennett, S. L. (1977). The infant's stimulus world during social interaction. In H. R. Schaffer (Ed.), Studies in Mother-Infant Interaction, (pp. 177-202). London: Academic Press.

Stern, D. N., Spieker, S., Barnett, R. K., & MacKain, K. (1983). The prosody of maternal speech: Infant age and context related changes. Journal of Child Language, 10, 1-15.

Sullivan, J. W. & Horowitz, F. D. (1983). The effects of intonation on infant attention: The role of the rising intonational contour. Journal of Child Language, 10, 521-534.

Symons, D. K., Moran, G., & Acton, H. (April, 1989). A longitudinal investigation of expressive behaviours in early mother-infant interactions: The effects of infant attentiveness. Paper presented at the Biennial Meeting of the Society for Research in Child Development, Kansas City, MO.

Tronick, E., Adamson, L., Wise, S., Als, H., & Brazelton, T. B. (April, 1975). The infant's entrapment between contradictory messages in face-to-face interaction. Paper presented at the Biennial Meeting of the Society for Research in Child Development, Denver, CO.

Turkewitz, G., Birch, H. G., & Cooper, K. K. (1972). Responsiveness to simple and complex auditory stimuli in the human newborn. Developmental Psychobiology, 5, 7-19.

Walker, A. S. (1982). Intermodal perception of expressive behavior by human infants. Journal of Experimental Child Psychology, 33, 514-535.

Walker-Andrews, A. (1988). Infants perception of the affordances of expressive behaviors. In C. Rovee-Collier & L. P. Lipsitt (Eds.), Advances in Infancy Research, Vol. 5, (pp. 173-221). Norwood, NJ: Ablex.

Walker-Andrews, A., Bahrick, L., Raglioni, S., & Diaz, I. (1991). Infants' bimodal perception of gender. Ecological Psychology, 3, 55-75.

Walker-Andrews, A. & Grolnick, W. (1983). Discriminations of vocal expressions by young infants. Infant Behavior and Development, 6, 491-498.

Werker, J. F. & McLeod, P. J. (1989). Infant preference for both male and female infant- directed talk: A developmental study of attentional and affective responsiveness. Canadian Journal of Psychology, 43(2), 230-246.

Wilcox, B. M. & Clayton, F. L. (1968). Infant visual fixation on motion pictures of the human face. Journal of Experimental Child Psychology, 6, 22-32.

Wolff, P. H. (1961). Observations on the early development of smiling. In B. M. Foss (Ed.), Determinants of Infant Behavior II, (pp. 113-138). New York: John Wiley & Sons.

Wolff, P. H. (1966). The causes controls and organization of behavior in the neonate. <u>Psychological Issues</u>, <u>5</u>(1), Monograph 17, 7-11. New York: International University Press.

Wolff, P. H. (1987). <u>The Development of Behavioral States and Expressions of Emotion in Early Infancy: New Proposals for Investigation</u>, (pp. 99-191). Chicago, IL: University of Chicago Press.

Young-Browne, G., Rosenfeld, H. M., & Horowitz, F. D. (1977). Infant discrimination of facial expressions. <u>Child Development</u>, <u>49</u>, 555-562.

Table 1: <u>Experimental conditions for longitudinal study of infant responses to static and dynamic bimodal affective displays</u>

	Age	2 months				3 1/2 months			
	Face	Happy		Sad		Happy		Sad	
	Voice	Happy	Sad	Happy	Sad	Happy	Sad	Happy	Sad
Dynamic									
Static									

Table 2: Results of the Analysis of Variance on Total Looking Time

Effects	d.f.	S.S.	M.S.	*F*
Condition	1,17	598.78	598.78	4.81*
Age	1,17	65.36	65.36	0.30
Trial	3,51	63.45	21.15	0.54
Age X Condition	1,17	76.40	76.40	0.35
Age X Trial	3,51	37.27	12.42	0.29
Trial X Condition	3,51	66.46	22.15	0.57
Trial X Age X Condition	3,51	104.18	34.73	0.82

Note. * $p<.05$

Table 3: Results of the Analysis of Variance on Average Look Length

Effects	d.f.	S.S.	M.S.	*F*
Condition	1,16	515.57	515.57	0.94
Age	1,16	2228.71	2228.71	2.80
Trial	3,48	315.56	105.19	1.19
Age X Condition	1,16	503.60	503.60	0.63
Age X Trial	3,48	259.56	86.52	0.70
Trial X Condition	3,48	324.62	108.21	1.23
Trial X Age X Condition	3,48	359.77	119.92	0.97

Table 4: Results of the Analysis of Variance on Infant Facial Affect Scores

Effects	d.f.	S.S.	M.S.	*F*
Condition	1,16	0.27	0.27	0.13
Age	1,16	2.55	2.55	5.40*
Trial	3,48	0.66	0.22	2.61**
Age X Condition	1,16	0.33	0.33	0.71
Age X Trial	3,48	0.12	0.04	0.62
Trial X Condition	3,48	0.07	0.03	0.29
Trial X Age X Condition	3,48	0.12	0.04	0.60

Note. * $p<.05$; ** marginally significant

Table 5: Frequency of More Happy / Less Happy Ratings at 2 and 3 1/2 Months for Each Trial Type

	Trial Type			
Rating	SFSV	SFHV	HFSV	HFHV
		2 Months		
More Happy	15	20	21	21
Less Happy	21	16	15	15
		3 1/2 Months		
More Happy	20	21	23	28*
Less Happy	16	15	13	8

Note. * $p<.05$

Table 6: Frequency of Presence / Absence of Smiling at 2 and 3 1/2 Months for Each Trial Type

Rating	Trial Type			
	SFSV	SFHV	HFSV	HFHV
	2 Months			
Presence Smiling	11*	13*	9*	10*
Absence Smiling	25	23	27	26
	3 1/2 Months			
Presence Smiling	15	16	22	21
Absence Smiling	21	20	14	15

Note. * $p<.01$

Table 7: Results of the Analysis of Variance on Infant Interactiveness Scores

Effects	d.f.	S.S.	M.S.	*F*
Condition	1,16	2.25	2.25	0.16
Age	1,16	28.44	28.44	8.93*
Trial	3,48	1.87	0.62	0.38
Age X Condition	1,16	36.34	36.34	11.41*
Age X Trial	3,48	10.38	3.46	2.38
Trial X Condition	3,48	6.85	2.28	1.40
Trial X Age X Condition	3,48	8.28	2.76	1.90

Note. * $p<.01$

Table 8: Factor loadings of questionnaire items

Items	Factor Loadings: Negative Resp. to Novelty	Positive Resp. to Play	Negative Affect	Positive Resp. to Face-to-Face Int.
1. resp. to new person	.75	.06	-.06	.06
2. resp. to new place	.70	-.23	.10	.12
5. how easily upset?	.65	.17	.26	-.24
6. how easily calmed?	.48	.26	.07	.07
13. how excited by play	-.06	.83	.06	.10
12. how expressive	.12	.72	-.01	.04
3. resp. to inf. seat	-.09	-.12	.71	-.08
8. typical mood	.23	.09	.69	.11
7. how much pos. affect	.11	.40	.59	-.01
14. how typical was beh. in lab	.17	-.11	.04	-.01
10. freq. of interaction home	.01	.03	.04	.20
4. resp. to chg.in routine	.24	-.16	.36	.26
11. attention to faces	.10	.13	.04	.65
9. interest in faces	-.11	.12	-.04	.56

Table 9: Coefficient alphas of factors with all items included and with individual items deleted and Pearson Correlation Coefficients of individual items with factors

Factors / Deleted Items	Alphas	Correlation w/ Factor
Negative Response to Novelty	.77	----
1. response to new person	.71	.57
2. response to new place	.71	.59
5. how easily upset?	.68	.64
6. how easily calmed?	.76	.48
Negative Affect	.72	----
3. reaction to infant seat*	.76	.50
8. typical mood	.55	.62
7. how much positive affect	.62	.58
Positive Response to Play	.77	----
13. how excited by play?	----	.63
12. how expressive?	----	.63
Positive Response to Face-to-Face Interaction	.61	----
11. attention to faces	----	.44
9. interest in faces	----	.44

Note. * Dropped from final analyses.

Table 10: Results of Hierarchical Regression Analysis with infant characteristics as predictors of attrition at 2 months

Predictors	B	Adj. R^2	d.f.	R^2 increase
Negative Reaction to Novelty	.27	.18*	1,49	----
Negative Affect	.12	.20	1,49	.02
Positive Response to Play	.05	.19	1,49	-.01
Positive Response to Face-to-Face Interaction	-.02	.18	1,49	-.01
Total	R=.41	.17	4,45	

Note. * $p<.01$

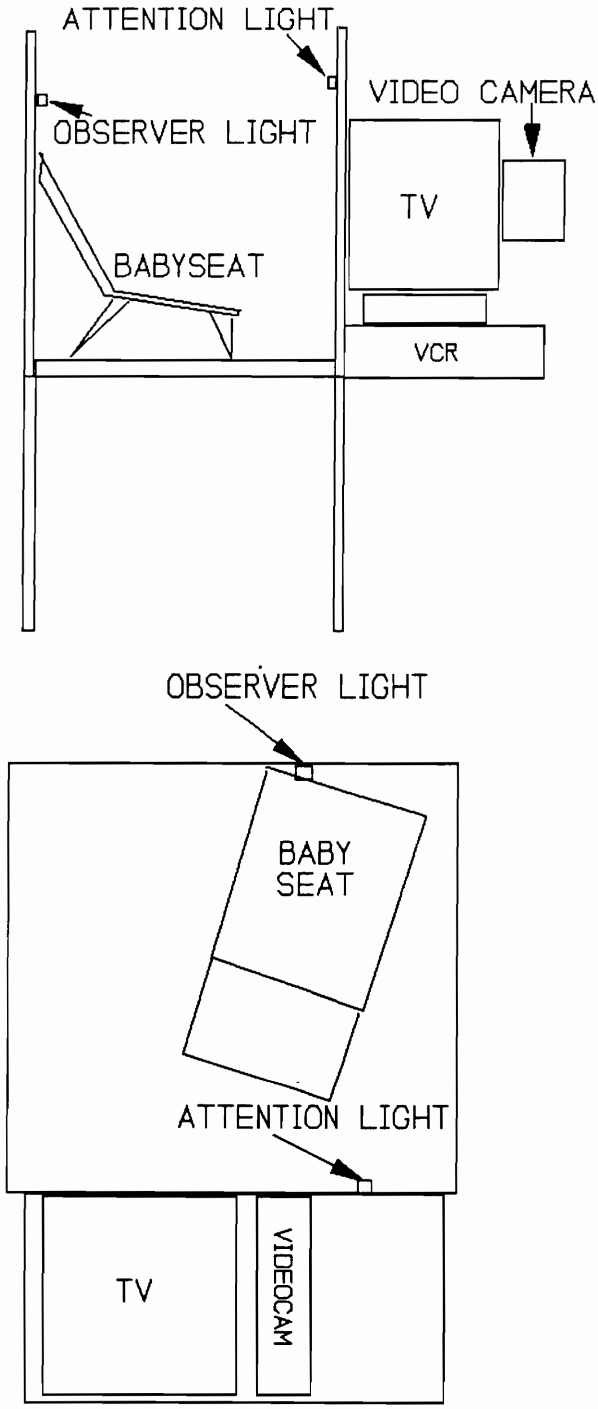

Figure 1: <u>**Infant perception apparatus**</u>

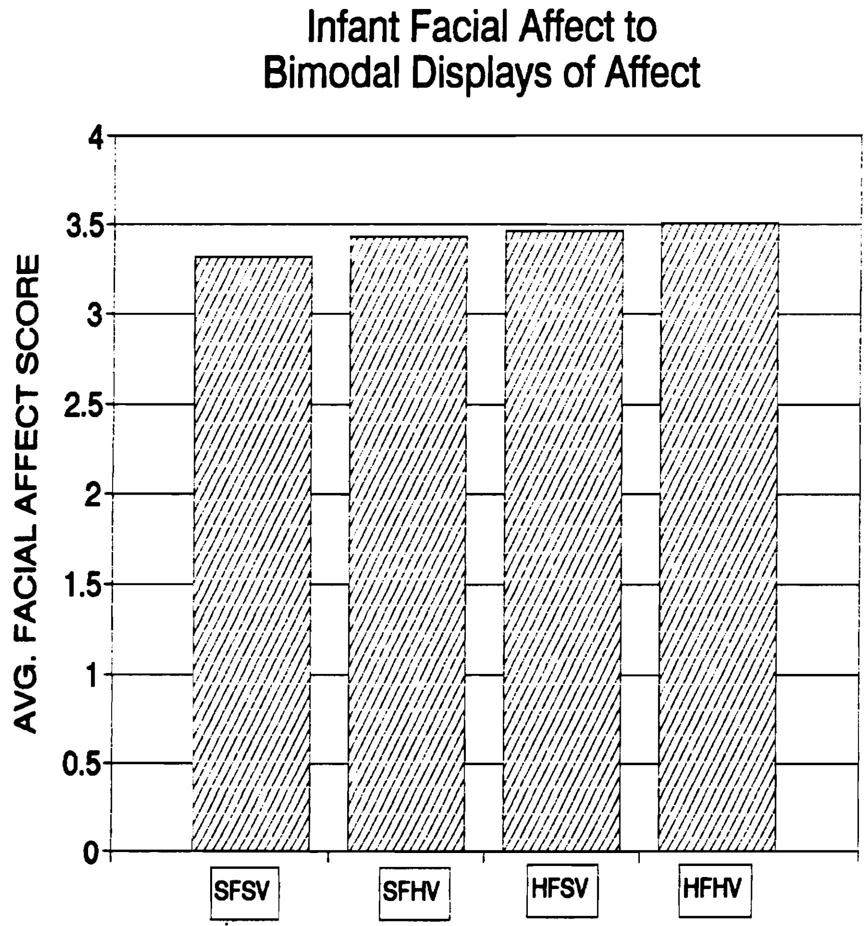

Figure 2: Average infant facial affect scores

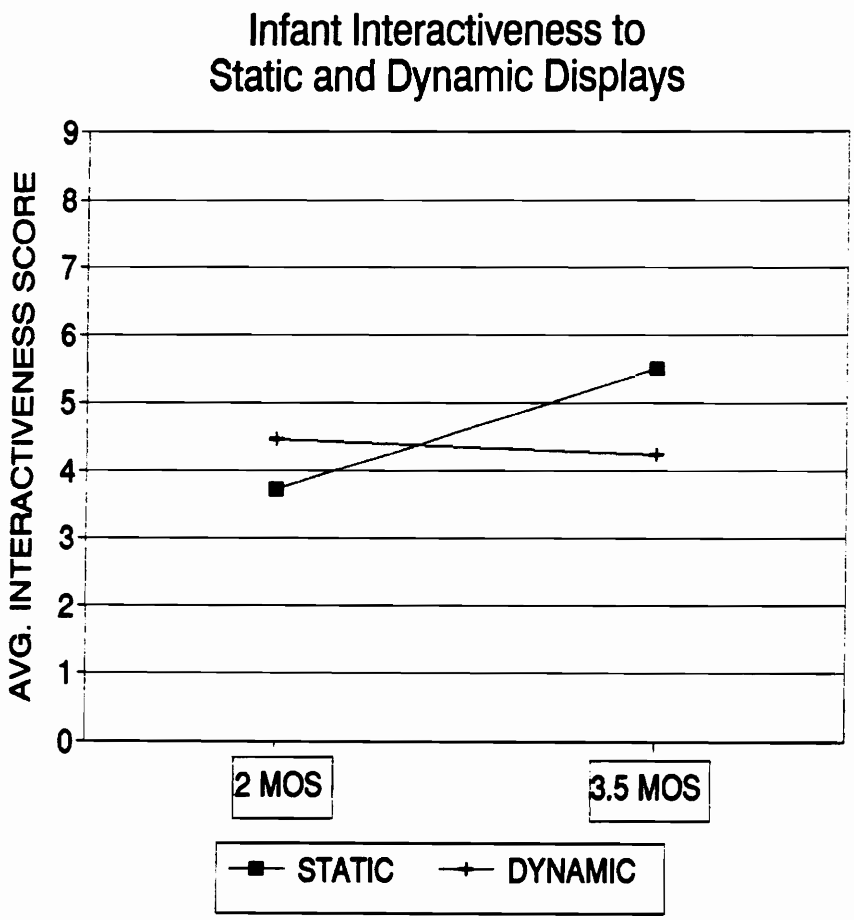

Figure 3: Average infant interactiveness scores

		AFFECT		
		Positive	Neutral	Negative
ATTENTION	More	attends more & displays positive affect	attends more & displays neutral affect	attends more & displays negative affect
	Less	attends less & displays positive affect	attends less & displays neutral affect	attends less & displays negative affect

Figure 4: <u>Proposed model of combined infant attention and affective responding</u>

Appendix A

Infant Face/Voice Preference Studies

Consent Form

I understand that my infant son/daughter will participate in a study designed to tell Dr. Cooper, Ms. Parker-Price, and their colleagues which types of faces and voices are most interesting to young infants. This study will be conducted in the Psychology Department at Virginia Tech. I have been informed of the testing procedure which involves placing my infant in an infant seat, presenting a series of videotaped face-voice combinations on a television monitor to the infant, and recording how long the infant looks at the television screen during various types of displays. I understand that the sound level of the speech played to my infant is no louder than the sounds heard by infants in their typical home environments and that my infant will view the video displays at a distance of approximately 40 cm. I also understand that my infant will be video-taped during the procedure, but that his/her name will be kept confidential when these tapes are studied. I have been given an opportunity to ask further questions about this procedure, and I understand that I have the right to end this session for any reason if I so choose. Having understood these conditions, I give my permission to Dr. Cooper, Ms. Parker-Price, and their colleagues to test my son/daughter.

______________________________   ________________
Signature of Parent   Date

______________________________   ________________
    Infant's Name

____
Address

______________________________   ________________
Signature of Experimenter   Infant's Birthdate

Appendix B

Infant Questionnaire

1. How does your baby typically respond to a new person?

1	2	3	4	5	6	7
almost always responds negatively at first			responds favorably about 1/2 the time			almost always responds favorably at first

2. How does your baby typically respond to being in a new place?

1	2	3	4	5	6	7
almost always responds negatively at first			responds favorably about 1/2 the time			almost always responds favorably at first

3. How does your baby typically respond to sitting in an infant seat when he/she is not in a moving car?

1	2	3	4	5	6	7
very well, seems to like it			minds a little or protests once in a while			doesn't mind at all

4. How does your baby respond to disruptions and changes in the everyday routine, such as when you go to church or a meeting, on trips, etc.?

1	2	3	4	5	6	7
almost always responds negatively at first			responds favorably about 1/2 the time			almost always responds favorably at first

5. How easy does your infant get upset?

1	2	3	4	5	6	7
very hard to upset, even by things that upset			about average			very easily upset by things wouldn't bother other babies

6. How easy or difficult is it for you to calm or sooth your baby when he/she is upset?

1	2	3	4	5	6	7
very easy			about average			difficult

7. How much does your baby smile and make happy sounds?

1	2	3	4	5	6	7
a great deal, more than other infants his/her age			about average			very little, much less than other infants his/her age

8. What kind of mood is your baby generally in?

1	2	3	4	5	6	7
very happy and cheerful			neither serious nor cheerful			serious

9. How interested is your baby in human faces?

1	2	3	4	5	6	7
very interested, faces captivate his/her attention more than other things			no more interested in faces than in other things			less interested in faces than in other things

10. How frequently is your baby engaged in face-to-face play with another individual during his/her waking hours? (These are times when your baby is attending to an adult/child who is talking and facing him/her. The other person may be diapering or feeding the infant or just playing with him/her.)

1	2	3	4	5	6	7
most of my baby's waking hours are spent interacting this way			about 1/2 of my baby's waking hours are spent interacting in this way			very little of my baby's time is spent this way

11. How responsive and attentive does your baby seem when people play with or talk to him/her?

1	2	3	4	5	6	7
almost always focuses on the person's face and responds to his/her actions			sometimes focuses on the other person, sometimes will not interact			rarely shows interest in people who try to interact with him/her

12. How emotionally expressive is your baby when people play with or talk to him/her?

1	2	3	4	5	6	7
very expressive, he/she smiles and makes happy noises			somewhat expressive, he/she shows expression with his/her eyes but rarely smiles			not very expressive, he/she shows expression with his/her eyes only

13. How excited does your baby become when people play with or talk to him/her?

1	2	3	4	5	6	7
very excited			about average			not at all

14. How typical was your infant's behavior for him/her during this visit to the lab?

1	2	3	4	5	6	7
my baby seemed much happier and more interested than usual			my baby behaved as he/she usually does			my baby seemed more fussy or sleepy than usual at this time of day

Appendix C

Infant Facial Affect Coding System

Five-sec epochs were rated according to the following categories. Raters were instructed to score an epoch with the numerical code that best described the infant's behavior when the infant was looking at the screen. Expressions that occurred when infants were not looking at the display area were not included in this rating, and epochs that were characterized by no looking at the screen were scored with a 0.

0 - no looking to the stimulus throughout the epoch

1 - grimace, fuss, cry

2 - frown, pout

3 - neutral, sober

4 - positive attention (eyebrow raising, eye brightening)

5 - partial to full smile

Appendix D

More Happy / Less Happy ratings were conducted by asking raters to answer the question, "How happy do you think the infant was during this trial relative to other trials in this session?"

MORE HAPPY ____________ LESS HAPPY ____________

Infant "interactiveness" ratings were conducted by asking raters to answer the question, "How much do you think the infant was trying to interact during this trial?"

1	2	3	4	5	6	7	8	9
Not interactive				ambivalent				Very interactive

CURRICULUM VITA

Susan Parker-Price

CURRENT ADDRESS

Department of Psychology
600 Park Street
Fort Hays State University
Hays, KS
(913)628-4000

BIRTH DATE AND PLACE

December 1, 1964; Los Angeles, California

EDUCATION

1988	B.S. Family and Child Development, Virginia Polytechnic Institute & State University, Blacksburg, VA
1990	M.S. Psychology, Virginia Polytechnic Institute & State University, Blacksburg, VA
1993	Ph.D. Psychology, Virginia Polytechnic Institute & State University, Blacksburg, VA

POSITIONS HELD AND RELEVANT WORK EXPERIENCE

Research

1991-93	Principle-Investigator, Psychology Department, Virginia Polytechnic Institute & State University, Blacksburg, VA; Young Infants' Attention and Affective Responses to Static and Dynamic Bimodal Affective Stimuli, Dissertation, supervised by Dr. Robin P. Cooper
1991	Co-Investigator, Psychology Department, Virginia Polytechnic Institute & State University, Blacksburg, VA; Teen-aged and Adult Mothers' Speech to Their Young Infants, supervised by Dr. Robin P. Cooper
1991	Research Assistant, Psychology Department, Virginia Polytechnic Institute & State

University, Blacksburg, VA; Responses of Preterm Infants to Controlled Visual Stimulation, supervised by Dr. Robert E. Lickliter

1990	Co-Investigator, Psychology Department, Virginia Polytechnic Institute & State University, Blacksburg, VA; Temporal Organization of Cry Sounds: A Comparison of Cry Rhythmicity in Infants With and Without Colic, Master's Thesis, supervised by Dr. Philip Sanford Zeskind
1990	Family Interviewer, Psychology Department, University of Virginia, Charlottesville, VA; Child Care and Family Project, supervised by Dr. Sandra Scarr
1989	Research Assistant, Psychology Department, Virginia Polytechnic Institute & State University, Blacksburg, VA; Learned-Helplessness in Mothers of Infants of Various Temperaments, supervised by Dr. Philip Sanford Zeskind
1989	Research Assistant, Psychology Department, Virginia Polytechnic Institute & State University, Blacksburg, VA; Non-nutritive Sucking in Infants of Atypical Fetal Growth, supervised by Dr. Philip Sanford Zeskind
1987-88	Research Assistant, Center for Gerontology, Virginia Polytechnic Institute & State University, Blacksburg, VA; Social and Psychological Adjustment to Widowhood, supervised by Dr. Rosemary Blieszner

Instruction

1993-pres	Assistant Professor, Psychology Department, Fort Hays State University, Hays, KS
1993	Instructor, Adolescent Development, Psychology Department, Roanoke College, Salem, VA
1992	Instructor, Developmental Psychology, Psychology Department, Virginia Polytechnic Institute & State University, Blacksburg, VA
1990-92	Instructor, Laboratory in Cognitive Psychology, Psychology Department, Virginia Polytechnic Institute & State University, Blacksburg, VA
1989-91	Psychology Tutor, Student Athletic Association, Virginia Polytechnic Institute & State University, Blacksburg, VA

1989-90	Graduate Teaching Assistant, <u>Nervous Systems & Behavior</u>, <u>Developmental Psychology</u>, <u>Introductory Psychology</u>, Psychology Department, Virginia Polytechnic Institute & State University, Blacksburg, VA
1988-89	Graduate Teaching Assistant, <u>Introductory Psychology</u>, Psychology Department, Virginia Polytechnic Institute & State University, Blacksburg, VA
1987-90	Crisis Intervention Trainer, RAFT Community Crisis Center, Blacksburg, VA
1987	Summer Program Instructor, New River Valley Agency for the Mentally Retarded, Pulaski County, VA

<u>Other Relevant Experience</u>

1992	Participant, <u>Training of the Future Professorate Lecture Series</u>; Virginia Polytechnic Institute & State University, Blacksburg, VA
1991	Infant Assessment Specialist, Well-Baby Clinic, Student Health Services, Virginia Polytechnic Institute & State University, Blacksburg, VA
1986-90	Volunteer Counsellor, RAFT Community Crisis Center, Blacksburg, VA

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

American Psychological Association; Student Member
American Psychological Society; Student Associate
Graduate Student Assembly, Virginia Polytechnic Institute & State University; Psychology Department Delegate, 1990-91
International Society for Infant Studies; Student Member
Omicron Nu, National Honor Society; Member
Phi Upsilon Omicron, National Honor Society; Member
Psi Chi, National Honor Society in Psychology; Member
Virginia Tech Gerontological Association; Vice President, 1987-88
Volunteer Advisory Council, RAFT Community Crisis Center; President, 1989-90

AWARDS AND HONORS

Tuition Scholarship from the Department of Psychology, 1991, 1992

Contributions to Faculty and Fellow Students Award from the Department of Family and Child Development, 1988

Outstanding Volunteer Service Award from the Community Services Board of Southwest Virginia, 1988

MANUSCRIPTS IN PRESS

Zeskind, P. S., Parker-Price, S., and Barr, R. G. (in press). Rhythmic organization of the sound of infant crying. Developmental Psychobiology.

MANUSCRIPTS IN PROGRESS

Parker-Price, S. Young infants' attention and emotional responses to static and dynamic bimodal affective stimuli.

Parker-Price, S., Zeskind, P. S., and Barr, R. G. The rhythmic organization of crying in infants with and without colic.

PAPERS PRESENTED

Boyd, C. M., Zeskind, P. S., and Parker-Price, S. (April, 1991). The behavioral effects of non-nutritive sucking on infants of differential fetal growth. Paper presented at the biennial meeting of the Society for Research in Child Development, Seattle, WA

Parker-Price, S., Cooper, R. P., and Piston, J. (May, 1992). Teen-aged and adult mothers' speech to their young infants. Paper presented at the biennial International Conference on Infant Studies, Miami Beach, FL

Parker-Price, S., Zeskind, P. S., and Barr, R. G. (April, 1991). Temporal organization of cries in infants with and without colic. Paper presented at the biennial meeting of the Society for Research in Child Development, Seattle, WA

Parker-Price, S., Zeskind, P. S., and Barr, R. G. (October, 1990). Temporal organization of infant crying. Paper presented at the Virginia

Developmental Forum, Fairfax, VA

Parker-Price, S. and Blieszner, R. (May, 1988). Widowers' maintenance of social support systems as related to their sex stereotyping tendencies. Paper presented at the annual meeting of the American Home Economics Association, Roanoke, VA

GRANTS RECEIVED

1991 Graduate Research Development Project Grant, Virginia Polytechnic Institute & State University, Blacksburg, VA

GRANTS SUBMITTED

1993 Physical Contact in Parent-Infant Play at 3 and 6 Months; Individual National Research Service Award Grant, National Institute of Mental Health, Rockville, MD; sponsored by Dr. Alan Fogel, Department of Psychology, University of Utah, Salt Lake City, UT

Susan Parker-Price

Susan Parker-Price, Ph.D.