Longitudinal Development of Attention to Hemispheric Lateralization in Emotion Perception

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Introduction

The human visual system plays an important role in the dynamics of social interaction. The direction of eye gaze and amount of pupil dilation can indicate attention and provide insight into the cognitive processes that may affect the initial elements of a decision. Farroni, Massaccesi, Pividori, and Johnson (2004) tracked the eye movements of infants and found that newborns can attend to the visual systems of target faces, which indicates that humans join this social interaction system immediately. Dodd, Van der Stigchel, and Hollingworth (2009) tracked the eye movements of adults and found the complexities of the visual system extend to visual search strategies (inhibition of return and facilitation of return) where people return faster or slower to a previously viewed part of a scene depending on context, which demonstrates that visual search is not random. This is important in being able to prioritize elements of a scene to examine, particularly during a limited viewing.

Emotional expressions serve to communicate our emotional state to others (Wilson, 2006), deceive others regarding our emotional expressions (Feldman, 2009), and give us information through which to interpret our own emotions (Levenson, Ekman, & Friesen, 1990). There are six basic emotions and expressions (anger, fear, disgust, sadness, happiness, and surprise) as well as others that occur cross-culturally (Ekman, 1992), and, to make things more complicated, we must deal with affect blends (Szameitat et al., 2009) and ambivalent emotions (Larsen, McGraw, & Cacioppo, 2001; Larsen, To, & Fireman, 2007). It is important to a perceiver to accurately perceive the emotions of others (though it may be important to the other person to be deceptive with their emotional expression), as this can communicate intentions and give the perceiver an opportunity to predict the behavior of the expresser.

Over the last two decades, there has been an increase in interest in eye movement research, but very few of these studies have focused on typically-developing infants and toddlers. The majority of infant and toddler studies have been with inanimate objects that are unfamiliar to the participants. Studies that have included familiar stimuli lack the benefit of using eye tracking technology.

The aim of this study is to investigate the development of human emotion perception. The rationale is that emotion perception is dynamic, rather than stable, and changes across time as children get more experience with a variety of subtle adult expressions. We hypothesize that

children focus on very specific cues that reveal information about the emotional state of the target.

The current longitudinal case study provides new information of a child's interest in familiar scenes and objects. The researchers presented the participant with still images of scenes and objects from the participant's home. While viewing these images, the participant's eye movements were recorded by an eye tracking device. The participant was presented with these images in a video at the age of 15 months, and with still-frame images at the ages of 27 months, 33 months, 38 months, and 47 months.

Methods

Participant

After gaining parental consent, one male participant was assessed at the ages of 15 months, 27 months, 33 months, 38 months, and 47 months.

Procedure

An Applied Sciences Laboratory Series 5000 eye tracker captured the participant's eye movements, including eye fixation coordinates and gaze trajectories. The parents of the participant recorded approximately 11 minutes of digital video footage at the infant's home. The video footage included objects and scenes frequently encountered by the participant. The original video was made into slides containing images of scenes and objects that the participant encountered frequently, omitting images that were encountered less frequently. The calibration procedure consisted of Sesame Street characters appearing on the screen one at a time on each of the nine calibration points. The character appeared on each point long enough for calibration, and then disappeared so there was only one point of focus on the screen at a time.

The parent held him while the participant watched approximately 11 minutes of video footage (15 months) and 8 minutes of image slides (27, 33, 38, and 47 months) consisting of scenes and objects from the participant's home. Each slide appeared on the screen for approximately 5 s. Each slide was followed by a buffer screen that readjusted the participant's pupil diameter and prepared him to view the next slide. The slides were watched in one session at each age. After the participant viewed all of the slides, the parents and the researchers discussed each slide.

Results and Discussion

General Gaze Patterns

At 15 months, the participant's gaze fixations were focused on facial features of the objects in the video. At 27 months, the participant's gaze patterns fixated less on facial expressions, but included fixations on the body parts of the images. At 33 months, the participant called the objects out by name with no instruction from his parent or the researcher. The participant reached out for certain objects as they appeared on the screen as if they were in the room. The participant showed ownership of objects that he frequently encountered by referring to them as "mine." In certain images, the participant recognized emotional expressions. At 38 months, the participant's eye movements were more methodical and there were fewer fixations. The participant was able to correctly identify objects without fixating on the image, as he looked at the objects peripherally. At 47 months, data collection problems and equipment malfunction occurred during the session, making it difficult to evaluate cognitive development based on eye movement patterns. The participant identified objects in the images upon prompting by the parent. Unlike previous sessions, the participant did not discuss the objects.

Emotion Gaze Patterns

Most interesting was the participant's development of perception of emotion at 33 months. When viewing pictures of his parents' faces smiling and frowning, there were substantial shifts in the gaze patterns across time (Table 1).

The participant focused his gaze patterns on two key regions for emotional expression: the zygomaticus major muscle and the corrugator supercilli muscle on the left side of each target's

Table 1. Fixations on familiar faces at 33 months.

	Right Side of Target Face	Left Side of Target Face
Mom (smiling)	3	272
Dad (smiling)	3	174
Mom (frowning)	4	273
Dad (frowning)	6	250
Self (crying)	7	203

face. The zygomaticus major muscle is engaged in a Duchenne's smile, while the corrugator supercilli is engaged in frowning. Both are commonly measured in facial electromyography as measures of attitude (cf., Mather & Romo, 2007; Tassinary & Cacioppo, 2000). This is a very effective area to attend to in perceiving emotions in others. Research has established hemispheric lateralization in humans (Corballis, 2009) and chimpanzees (Hopkins, Russell, & Cantalupo, 2007), and that the left side of the human face is more expressive than the right side due to being connected to the more expressive right hemisphere (Cacioppo & Petty, 1981; Sackeim & Gur, 1978).

Conclusions

The main findings of this study are the evidence at age 33 months of perception of cues consistent with the attention to hemispheric lateralization of emotion in a target. The location of these cues may be the most effective place to attend to decode emotional expressions in adults (or at minimum the parents who were used in the photos), and their frequency of use may be a result of experience. The appearance of this pattern at 33 months indicates that cognitive processes developed during that time period.

The major limitation of this study was the fact that it was a case study design and thus lacks external validity. However, this design allowed for repeated assessment of personalized stimuli in a controlled laboratory setting. Future research should test the development of gaze patterns across early development as well as differences in response to different types of emotion. This design should be used in a variety of samples, including young children with varying symptoms of autism spectrum disorder, in which social perception deficits occur.

Emotion perception is important for social interaction. The current findings contribute to the growing body of developmental eye tracking research with young children that builds our knowledge of development of human social perception.

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References

Cacioppo JT, Petty RE. 1981. Lateral asymmetry in the expression of cognition and emotion. Journal of Experimental Psychology: Human Perception and Performance 7:333-341.

Corballis MC. 2009. The evolution and genetics of cerebral asymmetry. Philosophical Transactions of the Royal Society B 364:867-879.

Dodd, MD, Van der Stigchel, S, Hollingworth, A. 2009. Novelty is not always the best policy: Inhibition of return and facilitation of return as a function of visual task. Psychological Science 20:333-339.

Ekman, P. 1992. An argument for basic emotions. Cognition and Emotion, 6:169-200.

Farroni, T, Massaccesi, S, Pividori, D, Johnson, MH. 2004. Gaze following in newborns. Infancy 5:39-60.

Feldman, R. 2009. The liar in your life: The way to truthful relationships. New York: Twelve. 292 p.

Hopkins WD, Russell JL, Cantalupo C. 2007. Neuroanatomical correlates of handedness for tool use in chimpanzees (*Pan Troglodytes*): Implications for theories on the evolution of language. Psychological Science 18:971-977.

Larsen, JT, McGraw, AP, Cacioppo, JT. 2001. Can people feel happy and sad at the same time? Journal of Personality and Social Psychology 81:684-696.

Larsen, JT, To, YM, & Fireman, G. 2007. Children's understanding and experience of mixed emotions. Psychological Science 18:186-191.

Levenson, RW, Ekman, P, Friesen, WV. 1990. Voluntary facial action generates emotion-specific autonomic nervous system activity. Psychophysiology 27:363-384.

Mather RD, Romo A. 2007. Automaticity and cognitive control in social behavior. Southlake (TX): Fountainhead.

Sackiem HA, Gur RC. 1978. Lateral asymmetry in intensity of emotional expression. Neuropsychologia 16:473-481.

Szameitat, DP, Alter, K, Szameitat, AJ, Darwin, CJ, Wildgruber, D, Dietrich, S., Sterr, A. 2009. Differentiation of emotions in laughter at the behavioral level. Emotion 9:397-405.

Tassinary LG, Cacioppo JT. 2000. The skeletomotor system: Surface electromyography. In: Cacioppo JT, Tassinary LG, Bernston GG, editors. Handbook of psychophysiology (2nd ed.). New York (NY): Cambridge University Press. p. 163-199.

Wilson, EO editor. 2006. From so simple a beginning: The four great books of Charles Darwin. New York: Norton. 1706 p.

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