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Orientation biases for facial emotion recognition during childhood and adulthood



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ABSTRACT

Facial emotion recognition develops slowly, with continuing changes in performance observable up to 10 years of age and beyond. In the current study, we chose to examine how the use of specific low-level visual features for emotion recognition may change during childhood. Adults exhibit information biases for face recognition; specific spatial frequency and orientation sub-bands make a larger contribution to recognition than others. This means that depending on the specific task (e.g., identification, emotion recognition), participants will perform worse when some features are removed from the original image and better when those features are included. One example of such an information bias for face recognition is the differential contribution of horizontal orientation energy relative to vertical orientation energy; adult participants are better able to recognize faces and categorize their emotional expressions when horizontal information is included than when only vertical information is included. Although several recent studies have demonstrated various ways in which horizontal orientation energy (and so-called “bar-codes” for face appearance) contribute to adult face processing, there have been as yet no studies describing how such a bias emerges developmentally that may offer insight into the mechanisms underlying the slow development of facial emotion recognition. In the current study, we compared children’s (5- and 6-year-olds and 7- and 8-year-olds) and adults’ performance in a simple emotion categorization task using orientation-filtered faces to determine the extent to which horizontal and vertical orientation energy contributed to recognition as a function of age. We found that although all three participant groups exhibited a clear bias favoring

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the use of horizontal orientation energy, the nature of this bias differed as a function of age. Specifically, 5- and 6-year-olds exhibited a disproportionate performance cost when vertical orientation energy was all that was available relative to when stimuli were limited to horizontal orientation energy. One feature of the development of facial emotion recognition, thus, appears to be the capability to use suboptimal or weakly diagnostic information to support recognition.

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Introduction

Extracting emotion information from facial expressions has obvious importance to successful social behavior, and adult observers are typically able to rapidly and accurately categorize facial emotion. Facial emotion recognition is nonetheless a challenging problem domain because multiple categories of facial expression can be signaled using appearance variation across the entire face, all with varying magnitudes. Despite evidence suggesting that infants are capable of facial emotion recognition during the first year of life (Bornstein & Arterberry, 2003) and establish emotion category boundaries during infancy (Leppanen, Richmond, Vogel-Farley, Moulson, & Nelson, 2009), there appears to be continued development of facial emotion recognition during childhood. Specifically, emotion recognition appears to develop slowly, with continued increases in performance for some emotion categories observable from early childhood (5–6 years of age) into late adolescence. Gao and Maurer (2009, 2010), for example, examined children's sensitivity to low-intensity emotional expressions and found that although young children (5-year-olds) were as sensitive as adults to happiness, sensitivity to sadness did not reach adult levels until 10 years of age. Sadness and fear were mutually confusable before this point, demonstrating slow development of facial emotion recognition when subtle cues must be interpreted. Similar results were reported by Mancini, Agnoli, Baldaro, Bitti, and Surcinelli (2013), who observed continued increases in emotion recognition performance between 8 and 11 years of age, driven primarily by changes in sadness recognition, and by Thomas, De Bellis, Graham, and LaBar (2007), who found differences between adult and adolescent sensitivity to anger and fear. Using a same/different matching paradigm in which simultaneously presented images of relatively high-intensity facial expressions were to be labeled as coming from the same emotion categories or different ones, Johnston, Kaufman, Bajic, Sercombe, and Michie (2011) also observed evidence supporting late development of emotion recognition. Specifically, they found that facial emotion recognition “lagged” behind identity matching and complex pattern matching (butterfly wings were used as a control stimulus) in 8- to 15-year-olds. Slow development of emotion recognition also appears to extend to dynamic faces. Montirosso, Peverelli, Frigerio, Crespi, and Bogartti (2010) reported developmental changes in multiple emotion categories when dynamic videos depicting facial expressions were presented to 4- to 18-year-olds, suggesting that even rich spatiotemporal inputs require extended development to be interpreted correctly. Overall, we take these results as convergent evidence that facial emotion recognition, although often studied with a wide variety of tasks and different subsets of emotion categories (Herba & Phillips, 2004), continues to develop during childhood. In the current study, we chose to investigate how facial emotion recognition may change during childhood in terms of the information that children and adults use to categorize faces by emotional expression. Given that accuracy/sensitivity to emotional expressions changes during childhood, are there changes in what visual features observers use to judge facial emotion?

If we are interested in what information children and adults use to recognize facial emotion as a function of development, what visual features should we consider? Faces are rich multidimensional stimuli that can be described using a wide range of features. For example, we may choose to describe facial appearance in terms of the shape of intuitive features such as the eyes, nose, and mouth. The arrangement of these face parts relative to one another, which is often described as the *configuration*

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