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Perceptual specialization and configural face processing in infancy

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ABSTRACT

Adults' face processing expertise includes sensitivity to second-order configural information (spatial relations among features such as distance between eyes). Prior research indicates that infants process this information in female faces. In the current experiments, 9-month-olds discriminated spacing changes in upright human male and monkey faces but not in inverted faces. However, they failed to process matching changes in upright house stimuli. A similar pattern of performance was exhibited by 5-month-olds. Thus, 5- and 9-month-olds exhibited specialization by processing configural information in upright primate faces but not in houses or inverted faces. This finding suggests that, even early in life, infants treat faces in a special manner by responding to changes in configural information more readily in faces than in non-face stimuli. However, previously reported differences in infants' processing of human versus monkey faces at 9 months of age (but not at younger ages), which have been associated with perceptual narrowing, were not evident in the current study. Thus, perceptual narrowing is not absolute in the sense of loss of the ability to process information from other species' faces at older ages.

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Introduction

Discrimination of faces is an important aspect of social interaction, and humans use several types of information for this purpose (Maurer, LeGrand, & Mondloch, 2002; McKone & Robbins, 2011; Mondloch, LeGrand, & Maurer, 2010). A critical type of information is *second-order spatial relations.* Diamond and Carey (1986) (see also Carey & Diamond, 1994) used the term "second-order relational information" to describe the specific distances between the features of the face (e.g., the distance between the eyes). Faces are relatively unique in that the gross configural information (what Diamond and Carey termed "first-order relational information," e.g., the eyes being above the nose) is identical for every face. Therefore, according to Diamond and Carey, adults use second-order relational information, in addition to featural information (e.g., shape of the eyes), to efficiently process faces. Diamond and Carey (1986) also suggested that the ability to use second-order relational information is necessary to gain expertise in face processing.

Prior research has documented infants' sensitivity to second-order configural information in female faces at 3, 5, and 7 months of age (Bhatt, Bertin, Hayden, & Reed, 2005; Hayden, Bhatt, Reed, Corbly, & Joseph, 2007; Quinn & Tanaka, 2009; Thompson, Madrid, Westbrook, & Johnston, 2001). The current research examined whether this capacity extends to human male and monkey faces and to house stimuli. Typically, infants have less experience with males than with females (Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002; Rennels & Davis, 2008) and very little (if any) exposure to monkeys. Moreover, prior research (discussed below) indicates that infants discriminate between female faces more readily than between male faces at 3 months of age (Quinn et al., 2002; Ramsey, Langlois, & Marti, 2005; Ramsey-Rennels & Langlois, 2006) and discriminate between human faces more readily than between monkey faces at 9 months of age and in adulthood (Mondloch, Maurer, & Ahola, 2006; Pascalis, de Haan, & Nelson, 2002; Pascalis et al., 2005; Scott & Monesson, 2009). Thus, if second-order relational processing in infancy is confined to categories of stimuli to which one has extensive exposure, it is possible that infants would fail to detect second-order configural changes in human male and monkey faces even though they detect similar changes in female faces. On the other hand, if infants detect spacing changes among features in human male and monkey faces as they do in female faces, it would suggest that the processing of second-order relational information in infancy extends to primate faces in general and does not require extensive experience with a particular subcategory of stimuli (Mondloch et al., 2006).

To examine the limits of specialization and configural processing, we also tested infants on house stimuli. Adults do not process spacing information in house stimuli as well as they do in faces (Leder & Carbon, 2006; Robbins, Nishimura, Mondloch, Lewis, & Maurer, 2010). Robbins and colleagues (2010) reported that spacing changes need to be four times as large in house stimuli as in human face stimuli for adults to exhibit the same level of discrimination. Such differences in adults' performance on face versus house stimuli have been thought to indicate specialization for face stimuli. If infants process spacing information in faces but not in matched house stimuli, it would suggest that the specialization for faces exhibited by adults has its origins early in life and that configural processing contributes to this specialization. If, on the other hand, infants discriminate spacing information in house stimuli, it would indicate that configural processing is not confined to faces, thereby suggesting that faces are not a "special" class of stimuli in infancy, at least as it pertains to second-order relational processing.

We also examined the relationship between second-order relational processing and perceptual narrowing by examining performance at both 5 and 9 months of age. Evidence suggests that face processing in infancy is subject to perceptual narrowing, such that infants become more specialized with age. For instance, in some studies 9-month-olds failed to discriminate between monkeys' faces under conditions in which 6-month-olds did discriminate (Pascalis, de Hann, & Nelson, 2002; Pascalis et al., 2005; Scott & Monesson, 2009; but see Fair, Flom, Jones, & Martin, 2012). These studies led to the conclusion that a key aspect of perceptual development involves specialization and narrowing: whereas younger infants are able to process information in a wide variety of stimuli, older infants become specialized on a subset of stimuli with which they have experience (e.g., human faces). This notion of perceptual narrowing, combined with prior studies in which 6-month-olds discriminated between monkey faces but 9-month-olds failed to do so (Pascalis et al., 2002), led to the prediction that