



# The development of expert face processing: Are infants sensitive to normal differences in second-order relational information?

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## Abstract

Sensitivity to second-order relational information (i.e., spatial relations among features such as the distance between eyes) is a vital part of achieving expertise with face processing. Prior research is unclear on whether infants are sensitive to second-order differences seen in typical human populations. In the current experiments, we examined whether infants are sensitive to changes in the space between the eyes and between the nose and the mouth that are within the normal range of variability in Caucasian female faces. In Experiment 1, 7-month-olds detected these changes in second-order relational information. Experiment 2 extended this finding to 5-month-olds and also found that infants detect second-order relations in upright faces but not in inverted faces, thereby exhibiting an inversion effect that has been considered to be a hallmark of second-order relational processing during adulthood. These results suggest that infants as young as 5 months are sensitive to second-order relational changes that are within the normal range of human variability. They also indicate that at least rudimentary aspects of face processing expertise are available early in life.

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## Introduction

It is generally accepted that face processing improves with development (Gauthier & Nelson, 2001; Maurer, Le Grand, & Mondloch, 2002; Pascalis & Slater, 2003). However, there is debate concerning the nature of this development. Some researchers have suggested that developmental changes in face processing involve a shift from reliance on featural information early in development to an increasing reliance on relational information with age (e.g., Carey & Diamond, 1994; Diamond & Carey, 1977, 1986; Joseph et al., 2006; Mondloch, Leis, & Maurer, 2006), whereas others have questioned the need to posit such qualitative changes in development (e.g., Itier & Taylor, 2004; McKone & Boyer, 2006; Pellicano, Rhodes, & Peters, 2006; Want, Pascalis, Coleman, & Blades, 2003).

The question of whether the development of face processing is characterized by a qualitative change in the use of featural versus relational information is significant because expertise in face processing has been associated with the use of relational information. Specifically, a prominent model of face processing proposed by Diamond and Carey (1977, 1986; see also Carey & Diamond, 1994) suggests that face processing expertise is based on the use of *second-order* relational information, which refers to the spatial relations among facial features (e.g., the distance between the eyes). Diamond and Carey distinguished second-order relations from *first-order* relations (the categorical relations among features, e.g., the fact that the eyes are *above* the nose) and from *featural* information (the discrete components of the face, e.g., eyes and nose).

Diamond and Carey (1986) posited that second-order relational processing is generally used with categories of objects with which a person has expertise. Thus, for many people, second-order relational processing is used solely for face processing because faces are the only objects with which they have had enough experience to employ this type of processing. Dog experts and car experts are two groups of people who have been found to use such information to identify dogs and cars, respectively (Diamond & Carey, 1986; Gauthier & Curby, 2005).

If relational processing, and specifically second-order relational processing, underlies expertise in face processing, then the question arises as to the nature of the development of sensitivity to this information. This question has generated considerable debate. Mondloch and colleagues (2006) suggested that the ability to detect second-order relational information begins at approximately 5 or 6 years of age and becomes more refined after that. In their study, 4-year-olds did not even exhibit sensitivity to second-order information. In contrast, other studies have claimed to obtain evidence of second-order processing that is adult-like even by 4 years of age (e.g., McKone & Boyer, 2006; Pellicano et al., 2006). Also, others have claimed evidence of sensitivity to second-order information during infancy (e.g., Bertin & Bhatt, 2004; Bhatt, Bertin, Hayden, & Reed, 2005; Rose, Jankowski, & Feldman, 2002; Thompson, Madrid, Westbrook, & Johnston, 2001). For instance, Thompson and colleagues (2001) concluded that 7-month-olds in their study exhibited sensitivity to second-order relational information because they preferred unaltered faces to ones in which second-order (spacing) information had been altered. Bhatt and colleagues (2005) found that when infants were habituated to a second-order distorted face (eyes moved apart and mouth moved down) and tested with that face paired with a normal face, 5-month-olds looked longer at the novel, more prototypical face. In contrast, 3-month-olds failed to discriminate. Bhatt and colleagues concluded

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