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The relationships between processing facial identity, emotional expression, facial speech, and gaze direction during development

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ABSTRACT

Four experiments were conducted with 5- to 11-year-olds and adults to investigate whether facial identity, facial speech, emotional expression, and gaze direction are processed independently of or in interaction with one another. In a computer-based, speeded sorting task, participants sorted faces according to facial identity while disregarding facial speech, emotional expression, and gaze direction or, alternatively, according to facial speech, emotional expression, and gaze direction while disregarding facial identity. Reaction times showed that children and adults were able to direct their attention selectively to facial identity despite variations of other kinds of face information, but when sorting according to facial speech and emotional expression, they were unable to ignore facial identity. In contrast, gaze direction could be processed independently of facial identity in all age groups. Apart from shorter reaction times and fewer classification errors, no substantial change in processing facial information was found to be correlated with age. We conclude that adult-like face processing routes are employed from 5 years of age onward.

Introduction

Although the face recognition abilities of infants are impressive, face processing continues to develop and improve during the first decade of life. With experience, children are increasingly able to determine that a specific facial identity has been encountered before and to assess its familiarity. The

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recognition of facial identity, however, is only one of several crucial aspects of the face processing system that also processes other social information such as emotional expression, facial speech, and gaze direction. In everyday life, all this information is presented simultaneously, leading to questions about how the face processing system masters this complexity and whether different kinds of face information are processed independently of or in interaction with one another.

Early research on face processing in adults assumed that processing of facial identity and emotional expression is independent (e.g., Bruce & Young, 1986; Etcoff, 1984), but more recent studies have demonstrated interactions between these dimensions (e.g., Gallegos & Tranel, 2005; Schweinberger, Burton, & Kelly, 1999; Schweinberger & Soukup, 1998). Very few studies have been conducted with children, and almost none of them has used the methods that have been applied in research on adults. As a consequence, the pattern of facial processing in children cannot be directly compared with that in adults. In the current study, we investigated the development of facial information processing in children using the methods that have previously been employed in adults (Schweinberger & Soukup, 1998). In particular, we examined whether or not 5- to 11-year-olds and adults process facial identity, facial speech, emotional expression, and gaze direction independently of or in interaction with one another.

Face processing models

The models of Bruce and Young (1986) and Haxby, Hoffman, and Gobbini (2000) are concerned with the integration of identity and social face information. In the Bruce and Young model, specialized modules for the processing of face identity, emotional expression and, facial speech are assumed to operate independently of one another. The authors argued that the initial visual encoding of an unfamiliar face results in viewer-centered descriptions, the so-called face recognition units, which form the basis for independent analyses of social face information (Bruce & Young, 1986). The Haxby and colleagues model postulates distributed face processing that employs two broadly defined systems. One is responsible for analyzing invariant aspects of faces, thereby building the basis for face identity recognition, and a second system is responsible for processing changeable aspects of faces such as emotional expression, facial speech, and gaze direction. The authors assumed that the systems interact and modulate each other resulting in a percept composed of identity and changeable social face information. In the following sections, we describe the extent to which previous findings from adults and children support independent or interactive processing of facial identity and social information such as emotional expression, facial speech, and gaze direction.

Processing identity and emotional expression in adults and children

In line with Bruce and Young (1986), some results indicate an independent processing of face identity and emotional expression in adults (Calder, Young, Keane, & Dean, 2000; Etcoff, 1984; Young, McWeeny, Hay, & Ellis, 1986). Further evidence for independent processing comes from brain studies. Single-cell recordings of the temporal cortex of monkeys (Desimone, 1991), as well as research in patients with prosopagnosia (e.g., Humphreys, Donnelly, & Riddoch, 1993; Schweinberger, Klos, & Sommer, 1995), demonstrate activation of different brain areas for the processing of different categories of facial information. Other adult studies do not support an independent processing of face identity and emotional expression but rather indicate interactive processing (e.g., Ganel & Goshen-Gottstein, 2004; Kaufmann & Schweinberger, 2004; Peng, 1989, quoted in Campbell, Brooks, de Haan, & Roberts, 1996; Schweinberger et al., 1999). In Schweinberger and Soukup (1998), for example, participants sorted faces varying in two dimensions (facial identity and emotional expression) according to one dimension only while disregarding the second dimension. The second dimension was varied under three conditions: the dimension either was held constant (control condition), was correlated with the first dimension (correlated condition), or varied independently of the first dimension (orthogonal condition). The pattern of reaction times allows conclusions to be drawn about independent or interactive processing of the two dimensions. No difference in reaction times in all three conditions is indicative of independent processing, whereas interactive processing is indicated if (a) reaction times in the correlated condition are shorter (redundant gain) or (b) reaction times in the