Journal of Experimental Child Psychology 102 (2009) 456–486

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

A cross-syndrome study of the development of holistic face recognition in children with autism, Down syndrome, and Williams syndrome

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ARTICLE INFO

Article history:
Received 16 August 2007
Revised 19 November 2008
Available online 3 February 2009

Keywords:
Autistic spectrum
Down syndrome
Williams syndrome
Developmental disorders
Face recognition
Holistic processing
Trajectory analyses
Benton

ABSTRACT

We report a cross-syndrome comparison of the development of holistic processing in face recognition in school-aged children with developmental disorders: autism, Down syndrome, and Williams syndrome. The autism group was split into two groups: one with three high-functioning children and one with low-functioning children. The latter group has rarely been studied in this context. The four disorder groups were compared with typically developing children. Cross-sectional trajectory analyses were used to compare development in a modified version of Tanaka and Farah's part–whole task. Trajectories were constructed linking part–whole performance either to chronological age or to several measures of mental age (receptive vocabulary, visuospatial construction, and the Benton Facial Recognition Test). In addition to variable delays in onset and rate of development, we found an atypical profile in all disorder groups. These profiles were atypical in different ways, indicating multiple pathways to, and variable outcomes in, the development of face recognition. We discuss the implications for theories of face recognition in both atypical and typical development, including the idea that part–whole and rotation manipulations may tap different aspects of holistic and/or configural processing.

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doi:10.1016/j.jecp.2008.11.005

Introduction

Faces have a special status as visual stimuli in terms of both their social relevance and the expertise that adults demonstrate in their recognition. Although infants show an early preference for faces (e.g., Johnson, Dziurawiec, Ellis, & Morton, 1991), investigation of the subsequent developmental course of face recognition has revealed different underlying processes and strategies that improve at different rates (e.g., Carey & Diamond, 1977; Freire & Lee, 2001; Maurer, Le Grand, & Mondloch, 2002). In this article, we focus on one of these processes, *holistic recognition,* and examine its developmental profile in typically developing (TD) children and children with three developmental disorders: autism, Down syndrome (DS), and Williams syndrome (WS).

Behavioral and neuroimaging experimentation has used several paradigms to investigate how individuals use visual information to recognize faces. These include (sometimes in combination) the manipulation of facial features such as eyes, mouth, nose, and facial outline; the presentation of these features in or out of the context of the face; the presentation of parts of faces such as the top or bottom half; and manipulation of the orientation at which the face is presented, for example, comparing upright and inverted presentations. Based on these paradigms, several processes have been identified and are broadly described as follows: (a) *holistic processing,* occasionally referred to as "global" or gestalt processing, where the face is recognized as a whole (holistic processing is sometimes conceived of in terms of a fast template-matching procedure [see also Diamond & Carey, 1986, for norm-based accounts; see Tanaka & Farah, 1993, and Tanaka & Sengco, 1997, for discussions of accounts based on the accessibility of different types of facial information]); (b) *featural processing,* also known as local or analytical face processing, where recognition is driven by individual features such as eyes, nose, and mouth; and (c) *configural processing,* where recognition is driven by the arrangement of the features in the face. This may be in terms of the relative positioning of the features, termed first-order configural information (e.g., eyes above nose), or in terms of the exact distances between features, termed second-order configural or relational information (e.g., eye separation). The contribution of these three processes to face recognition changes gradually with chronological age (CA), with configural processing being the last to emerge (Maurer et al., 2002; Mondloch, Le Grand, & Maurer, 2002).

In the following sections, we briefly review the research on holistic face recognition and its development and then consider the contrasting face recognition skills reported in the three developmental disorders.

Holistic face recognition

The role of parts and wholes in perception has long been a focus of research. The face is perhaps a unique example of a stimulus that is seen as an organized meaningful pattern that is difficult to break down into its parts without harming perception. Compelling examples of holistic processing come from two behavioral paradigms widely used to evaluate the existence of holistic face processing: the *part–whole* paradigm (Tanaka & Farah, 1993) and the *composite face effect* (Young, Hellawell, & Hay, 1987). In the part–whole paradigm, participants first memorize a set of target faces and learn names for them. They are then asked to identify features from one of the target faces (compared with a foil) presented either in isolation (e.g., "Which is Bill's nose?", where the foil is Bill's face with a different nose) or in the context of the whole face (e.g., "Which one is Bill?"). Stimuli are presented in either an upright or inverted orientation. Tanaka and Farah (1993) reported that adults were more accurate in recognizing individual features from the target face in the context of whole face (whole condition, 74%) than in isolation (part condition, 65%). However, when the stimulus was presented in an inverted orientation, recognition accuracy of features in the whole face decreased significantly (65%), whereas accuracy in the part condition was unaffected (64%). This pattern was not observed with other stimuli such as houses, where little difference was observed between the recognition of a house feature in the whole and part conditions (81% and 79%, respectively). These results are consistent with the idea that the upright whole face engages a fast template-matching recognition process that is unavailable for other stimuli or indeed for faces when they are inverted.