Journal of Experimental Child Psychology 101 (2008) 206–223

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

Rapid facial reactions to emotional facial expressions in typically developing children and children with autism spectrum disorder

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ARTICLE INFO

Article history:
Received 30 June 2007
Revised 5 March 2008
Available online 17 June 2008

Keywords:
Mimicry
EMG
Rapid facial reaction
Children
Autism
Faces

ABSTRACT

Typical adults mimic facial expressions within 1000 ms, but adults with autism spectrum disorder (ASD) do not. These rapid facial reactions (RFRs) are associated with the development of social–emotional abilities. Such interpersonal matching may be caused by motor mirroring or emotional responses. Using facial electromyography (EMG), this study evaluated mechanisms underlying RFRs during childhood and examined possible impairment in children with ASD. Experiment 1 found RFRs to happy and angry faces (not fear faces) in 15 typically developing children from 7 to 12 years of age. RFRs of fear (not anger) in response to angry faces indicated an emotional mechanism. In 11 children (8–13 years of age) with ASD, Experiment 2 found undifferentiated RFRs to fear expressions and no consistent RFRs to happy or angry faces. However, as children with ASD aged, matching RFRs to happy faces increased significantly, suggesting the development of processes underlying matching RFRs during this period in ASD.

Introduction

Seeing a smiling face makes most people smile, and seeing an angry face can make them scowl (Bush, Barr, McHugo, & Lanzetta, 1989; Dimberg, 1982; McIntosh, 2006; McIntosh, Druckman, &

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doi:10.1016/j.jecp.2008.04.004

Zajonc, 1994). The questions of why and how they do so have become increasingly important as our understanding of the role of interpersonal matching in development and social processes has expanded (Rogers & Williams, 2006). There is a wide variety of interpersonal matching behaviors, all of which include an observer engaging in behaviors similar to those of a model (Moody & McIntosh, 2006; Williams, Whiten, & Singh, 2004). Some of the more complex behaviors, such as imitation, likely build on components of the most simple behaviors, such as automatic matching of emotional facial expressions (Moody & McIntosh, 2006; Rogers, 1999). The current experiments examine these simple automatic facial responses in children. They are the first to demonstrate that facial electromyography (EMG) can be used to study these subtle and rapid responses in typically developing children and children with autism spectrum disorder (ASD). More important, Experiment 1 examines the mechanisms responsible for these rapid reactions, and Experiment 2 investigates these responses in children with ASD. Experiment 2 points toward the functional significance of these reactions and considers the development of matching in ASD.

Rapid facial reactions

Emotional facial mimicry is one type of rapid facial reaction (RFR). RFRs are commonly observed in adults after exposure to facial expressions. They occur very rapidly—within 1000 ms—and are often very subtle (Cacioppo, Petty, Losch, & Kim, 1986; Moody, McIntosh, Mann, & Weisser, 2007). Due to their speed and subtlety, investigators typically use EMG with surface electrodes placed over facial muscles to examine their occurrence. When an adult sees a picture of a happy facial expression, the muscles responsible for raising the cheek in a smile (zygomaticus major) typically show an increased level of activity; when an adult sees an angry expression, the muscles responsible for knitting the brows in a scowl (corrugator supercilii) may have greater activity (Dimberg, 1982, 1988; Moody et al., 2007). These RFRs can occur even when people are exposed to facial expressions so quickly that they cannot consciously recognize the expressions (Dimberg, Thunberg, & Elmehed, 2000; Rotteveel, de Groot, Geutskens, & Phaf, 2001).

RFRs that match the observed expressions are associated with several important social and emotional abilities. In particular, matching of facial expressions has been theorized to be critical for social functioning, emotional contagion, empathy, and understanding of another person's state of mind (Decéty & Chaminade, 2003; Hatfield, Cacioppo, & Rapson, 1993, 1994; Iacoboni, 2005; Lakin & Chartrand, 2003; McIntosh, 2006; Scambler, Hepburn, Rutherford, Wehner, & Rogers, 2007; Sonnby-Borgstroem, 2002). In terms of evolution, expression matching may be adaptive because it helps humans to communicate and foster relationships (Lakin, Jefferis, Cheng, & Chartrand, 2003). Moreover, matching behaviors in general have important developmental functions such as facilitating social and emotional connectivity and understanding (Bavelas, Beavin-Black, Lemery, & Mullett, 1987; Masur & Rodemaker, 1999). Indeed, early RFRs may be important precursors to later, more complex imitative processes often studied in ASD. Therefore, it is important to understand RFRs and the role they play in interpersonal development and imitation.

Although the presence of RFRs to emotional stimuli is well documented in adults (Dimberg, 1982, 1988; McIntosh, Reichmann-Decker, Winkielman, & Wilbarger, 2006), there has been less work examining facial responses to facial expressions in children. Some studies suggest that newborns and infants less than 1 month of age match simple facial movements (Meltzoff & Moore, 1977) and emotional expressions (Field, Woodson, Greenberg, & Cohen, 1982), although the evidence is inconsistent (Anisfeld, 1996; Kaitz, Meschulach-Sarfaty, Auerbach, & Eidelman, 1988). With development, there is more evidence of matching behaviors. Jones (2007) found that matching motor behaviors were not observed at 6 months of age but developed through the 2nd year of life. In addition, contagious yawning does not appear before 5 years of age, and the probability of occurrence continues to increase throughout childhood (Anderson & Meno, 2003). Evidence during toddlerhood for emotional responsiveness to others' emotion displays was provided by Scambler and colleagues (2007). They studied emotional responsiveness to live adult displays of joy, fear, disgust, and pain among 2-year-olds with ASD, children with other developmental delays, and typically developing children. The children's facial and behavioral responses were videotaped and coded for coordination in the valence of the emotion between child and experimenter. All groups showed some level of emotional respon-