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Facial EMG responses to dynamic emotional facial expressions in boys with disruptive behavior disorders

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Abstract

Based on the assumption that facial mimicry is a key factor in emotional empathy, and clinical observations that children with disruptive behavior disorders (DBD) are weak empathizers, the present study explored whether DBD boys are less facially responsive to facial expressions of emotions than normal controls. Facial electromyographic (EMG) activity in the zygomaticus major and corrugator supercilii muscle regions, and heart rate activity were studied in 22 clinically referred 8–12-year-old DBD boys and 22 age-matched normal controls during exposure to dynamic happy and angry expressions. Dispositional emotional empathy was assessed by a self-report questionnaire for children. The happy and angry facial expressions evoked distinct facial EMG response patterns, with increased zygomaticus muscle activity to happy expressions and increased corrugator muscle activity to angry expressions. The corrugator (but not the zygomaticus) muscle response pattern was less pronounced for DBD boys than the normal controls. Attending to the emotional expressions was associated with equivalent cardiac deceleration in both groups, reflecting a similar orienting/attention response. Lower empathy scores were obtained for DBD boys than for normal controls. In conclusion, facial mimicry responses to angry facial expressions were subnormal in DBD boys, which may be a sign of a deficient early component in the process of emotional empathy, and thus play a role in impaired empathic responding.

Keywords: Facial EMG; Conduct disorder; Oppositional defiant disorder; Mimicry; Empathy

1. Introduction

In clinical practice, children with oppositional defiant disorder (ODD) and conduct disorder (CD), also called disruptive behavior disorders (DBD), are thought to be poor in empathic skills, that is, the ability to understand and share another's emotional state (Cohen and Strayer, 1996). The clinical impression that DBD children are weak empathizers is given support by studies reporting empathy deficits in clinically identified CD adolescents (Cohen and Strayer, 1996), and DBD boys (de Wied et al., 2005). Starting from the assumption that facial mimicry is a fundamental component in the process of empathy, especially emotional empathy (i.e., *shared feelings*) (Hatfield et al., 1994; Hoffman, 2000; Meltzoff, 1993), the present study explored facial electromyographic (EMG) responses in clinically referred 8–12-year-old DBD boys and normal controls, when exposed to dynamic emotional facial expressions.

An early report by Lipps (1905) first called attention to the possible role of motor mimicry/imitation in the

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automatic transmission of emotions. Lipps proposed that people tend to mimic the facial, vocal or postural expressions of emotions displayed by an interaction partner, and that such mimicry responses may evoke corresponding emotions in the observer. Many researchers currently consider motor mimicry as the very essence of emotional empathy, likely to be biologically "hard-wired" (e.g., Hatfield et al., 1994; Hoffman, 2000; Meltzoff, 1993; Preston and de Waal, 2002).

According to Hoffman's (2000) developmental model of empathy, mimicry is an early component in the process of empathy. The tendency to automatically mirror emotional expressions becomes manifest already in the first days of life by reflexive crying in response to other babies' crying. Primitive mechanisms (e.g., mimicry) contribute to the development of empathy in the early preverbal period, but continue to operate past childhood. As the cognitive system develops, higher-order cognitive processes (e.g., role-taking) come to play a more important role. However, mature empathic responses are generated both by primitive (automatic) mechanisms and more sophisticated cognitive processes.

Focusing on facial imitation, Dimberg and colleagues (Dimberg, 1982, 1988, 1990; Dimberg and Lundquist, 1990) demonstrated that exposure to pictures of happy and angry faces evoke distinct facial EMG response patterns. Adult subjects react spontaneously with increased zygomaticus major (cheek) muscle activity when exposed to happy facial expressions, whereas angry facial expressions evoke increased corrugator supercilii (eyebrow) muscle activity. These facial EMG reactions are rapidly evoked (i.e., under 400 ms; Dimberg and Thunberg, 1998), also when subjects are unconsciously exposed to facial stimuli (Dimberg et al., 2000), and hard to restrain voluntarily (Dimberg et al., 2002). The data support the hypothesis that facial mimicry is an early, automatic response to others' facial displays.

Sonnby-Borgström and colleagues (Sonnby-Borgström, 2002; Sonnby-Borgström et al., 2003) conducted studies on facial EMG (zygomaticus and corrugator) and empathic sensitivity in high and low empathic students. When pictures of happy and angry expressions were presented at short exposure times (eliciting automatic reactions), the high-empathy group showed a stronger mimicry response than the low-empathy group. Furthermore, a significant correspondence between facial reactions and subjective feelings was found only among the high empathic students (Sonnby-Borgström, 2002), suggesting that those who show a stronger tendency to mimic other's facial expressions are more susceptible to emotional empathy.

The aim of the present study was to determine facial responsiveness in DBD boys and normal controls. Respondents were exposed to 5-s moving pictures showing a male model producing dynamic angry or happy facial expressions. We used dynamic presentations because moving images of facial expressions may constitute a stronger eliciting stimulus than static displays (Wehrle et al., 2000). Facial EMG activity in the zygomaticus major and corrugator supercilii muscle regions was assessed during exposure to the facial stimuli. Dispositional emotional empathy was assessed by a self-report questionnaire for children. Based on theory and empirical studies with adults, it was predicted that happy faces would evoke more zygomaticus activity than angry faces, whereas angry faces would evoke more corrugator activity than happy faces. In fact, corrugator activity tends to be inhibited during exposure to happy faces (Dimberg and Lundquist, 1990; Dimberg and Thunberg, 1998; Dimberg et al., 2000). Furthermore, it was predicted that this typical response pattern (i.e., increased zygomaticus activity during happy faces and increased corrugator activity during angry faces) would be less pronounced for DBD boys than for normal controls. Given the preliminary nature of this first study on facial EMG responses in DBD boys, no more specific hypotheses were formulated.

Attending to affective pictures or film clips is generally associated with cardiac deceleration (McManis et al., 2001; Waldstein et al., 2000), which may be reflective of an orienting or attention response (Cook and Turpin, 1997). Cardiac deceleration was also demonstrated during exposure to happy and angry facial expressions (Dimberg, 1982, 1990). To control for differences in heart rate responses during happy versus angry facial expressions, heart rate was also measured in the present study.

2. Methods

The Medical Ethics Committee of the University Medical Center Utrecht approved the study protocol, and parents gave written informed consent prior to participation.

2.1. Participants

In the present study, data were collected within the context of a larger study on empathy in DBD boys. Only boys were included because DBD is more prevalent among boys than girls (Maughan et al., 2004). The DBD group consisted of 8–12-year-old boys who had met the criteria for ODD ($n = 21$) or CD ($n = 4$) as set out in DSM-IV (American Psychiatric Association, 1994). In total, 25 DBD boys were recruited from inpatient ($n = 12$) and day-treatment ($n = 12$) units of the Department of Child and Adolescent Psychiatry, University Medical Center Utrecht, and from a special school for children with severe behavioral disorders ($n = 1$). Because the data of three participants were lost