Journal of Fluency Disorders 56 (2018) 81–99

Contents lists available at ScienceDirect

Journal of Fluency Disorders

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

Cortical associates of emotional reactivity and regulation in childhood stuttering

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ARTICLE INFO

Keywords:
Stuttering
Children
Emotion
Emotional reactivity
Regulation
Event-related potentials
ERPs
Late positive potential
LPP
Cortical
Brain

ABSTRACT

Purpose: This study sought to determine the cortical associates of emotional reactivity and emotion regulation (as indexed by the amplitude of evoked response potentials [ERP]) in young children who do and do not stutter during passive viewing of pleasant, unpleasant and neutral pictures.

Method: Participants were 17 young children who stutter and 22 young children who do not stutter (between 4 years 0 months to 6 years 11 months). The dependent measures were (1) mean amplitude of late positive potential (LPP, an ERP sensitive to emotional stimuli) during passive (i.e., no response required) picture viewing and directed reappraisal tasks and (2) emotional reactivity and regulation related scores on caregiver reports of young children's temperament (Children's Behavior Questionnaire, CBQ).

Results: Young CWS, when compared to CWNS, exhibited significantly greater LPP amplitudes when viewing unpleasant pictures, but no significant between-group difference when viewing pleasant pictures and during the emotion regulation condition. There were, however, for CWS, but not CWNS, significant correlations between temperament-related measures of emotion and cortical measures of emotional reactivity and regulation.

Conclusions: Findings provide further empirical support for the notion that emotional processes are associated with childhood stuttering, and that CWS's inherent temperamental proclivities need to be taken into account when empirically studying or theorizing about this association.

1. Introduction

Over the past several years, numerous empirical studies indicated that emotions play a role in early childhood stuttering (e.g., Anderson, Pellowski, Conture, & Kelly, 2003; Arnold, Conture, Key, & Walden, 2011; Choi, Conture, Walden, Jones, & Kim, 2016; Eggers, De Nil, & Van den Bergh, 2009, 2010; Embrechts, Ebben, Franke, & van de Poel, 2000; Felsenfeld, van Beijsterveldt, & Boomsma, 2010; Johnson, Walden, Conture, & Karrass, 2010). Recently, the Dual Diathesis-Stressor Model (Conture & Walden, 2012)

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https://doi.org/10.1016/j.jfludis.2018.04.001
Received 12 April 2017; Received in revised form 5 January 2018; Accepted 12 April 2018
Available online 19 April 2018
0094-730X/

and the Multifactorial Dynamic Pathways Theory (Smith & Weber, 2017) suggest that emotions are associated with childhood stuttering. Taken together, the aforementioned empirical studies and theoretical models involve, at the minimum, two aspects of emotion: (1) *emotional reactivity*, that is, "the ease by which emotions are aroused, which can involve reactions to novel stimuli, and/or orienting to internal or external stimulation" (Rothbart, 2011) and (2) *emotional regulation*, that is, "the processes by which we influence which emotions we have, when we have them, and how we experience and express them" (Gross, 1998). Although neither the empirical findings nor theoretical models propose that emotion is the main, primary or sole "cause" of childhood stuttering, they do suggest that any comprehensive account of childhood stuttering should include consideration of emotional processes. Below the present authors provide a brief review of essential findings regarding the association between emotion and childhood stuttering. This review is organized around the various methods used to empirically study this association, including (a) caregiver reports, (b) direct behavioral observations and experimental tests, and (c) psychophysiological measures.

First, evidence from *caregiver reports* suggests that when compared to children who do not stutter (CWNS), CWS display (a) lower inhibitory control, and higher anger/frustration (Eggers, De Nil, & van den Bergh, 2010), (b) greater emotional reactivity and greater difficulty in emotion regulation (e.g., Karrass et al., 2006), (c) greater difficulty in flexibly controlling and shifting attention when necessary (Eggers et al., 2010; Felsenfeld et al., 2010; Karrass et al., 2006), and (d) less adaptability to change (Anderson et al., 2003). Overall, these findings, based on parental reports to normed questionnaires, suggest that CWS are perceived as differing from their CWNS peers in emotion reactivity and emotion regulation processes.

In contrast, Kefalianos, Onslow, Ukoumunne, Block, and Reilly (2014), in a study of the temperament of a large cohort of CWS and CWNS at 2, 3, and 4 years of age replicated Anderson et al.'s (2003) and Howell et al.'s (Howell et al., 2004) findings of no significant talker-group differences in approach/withdrawal scores. Lewis and Goldberg (1997) reported that young CWS, when compared to CWNS, were less negative and more adaptable (cf. Anderson et al., 2003) and Williams (2006) reported that CWS were more likely to exhibit the temperamental constellation of an "easy child." Interestingly, however, Arnold et al. (2011) observed that in the Williams's study "…a higher proportion of CWS, compared to CWNS, fit the temperamental constellation of "slow to warm up" (p. 277). Perhaps, some of the differences in findings regarding caregiver reports of temperament in children who do and do not stutter relates to the use of different temperament scales. Indeed, these scales vary significantly in content, length, as well as breadth, depth and types of temperamental dimensions measured (e.g., the 30-item Short Temperament Scale for Children used in Kefalianos et al. (2014) study versus the 233-item Children's Behavior Questionnaire used in Eggers et al. (2010) study).

Second, researchers have used *direct behavioral observations* and *experimental tests* to study more variable/state-like/situational aspects of emotion and childhood stuttering. Findings from such studies indicate that when compared to their CWNS peers, CWS exhibit (a) more negative emotional expressions during a disappointing gift procedure (Johnson et al., 2010), (b) difficulty flexibly shifting attention from a stimulus (Bush, 2006); (c) more negative emotion and self-speech during an emotionally frustrating task (Ntourou, Conture, & Walden, 2013), (d) less ability to habituate to task-irrelevant environmental stimuli (Schwenk, Conture, & Walden, 2007), (e) less efficiency in the orienting subsystem of the attention network during a computerized attention network task (Eggers, De Nil, & Van den Bergh, 2012), and (f) lower inhibitory control during a Go/NoGo task (Eggers, De Nil, & Van den Bergh, 2013). In addition, emerging findings have shown that children who stutter and persist, compared to children who recover from stuttering and those who do not stutter, exhibit significantly slower articulation rates following a negative emotion condition (Erdemir, Walden, Jefferson, Choi, & Jones, 2018).

Studies investigating the association between CWS's emotions and their frequency of stuttering have indicated that young CWS exhibit (a) more emotionally reactive behaviors prior to and during stuttered than fluent utterances (Jones, Conture, & Walden, 2014), (b) increased stuttering frequency in association with decreased duration and frequency of behavioral regulatory strategies (Arnold et al., 2011), and (c) increased stuttering severity in association with caregiver-reports of lower effortful control skills (Kraft, Ambrose, & Chon, 2014). Likewise, Choi, Conture, Walden, Lambert, and Tumanova (2013) studied young CWS and CWNS in terms of possible behavioral inhibition (BI). BI is a temperamentally related attribute characterized by initial avoidance and distress in unfamiliar places, situations or the presence of unfamiliar people (Kagan et al., 1984 in Choi et al., 2013). Choi et al. (2013) reported that CWS with higher BI had more stuttering than CWS with lower BI. Overall, evidence from direct behavioral observations and experimental tests indicates that CWS differ from their CWNS peers in the manifestation of emotion regulation and reactivity and that CWS's increased stuttering is associated with increased emotional reactivity and decreased regulation.

More recently, researchers have used various *psychophysiological* methods to study the association between emotional processes and childhood stuttering. To date, psychophysiological findings from these studies indicate that when compared to their CWNS peers, young CWS exhibit (1) no significant differences in EEG frontal asymmetries (Arnold et al., 2011)[1]; (2) less emotion regulation (as indexed by parasympathetic activity), during a non-speaking baseline condition, as well as more counter-adaptive responses (as indexed by greater co-activation of both sympathetic and parasympathetic responses) during a speaking condition (Jones, Buhr et al., 2014); (3) significantly lower (Ortega & Ambrose, 2011) or no significant differences in salivary cortisol (van der Merwe, Robb, Lewis, & Osmond, 2011), (4) significantly higher emotional reactivity (indexed by tonic skin conductance level) in 3-year-old CWS and significantly lower emotional reactivity in 4-year-old CWS (Zengin-Bolatkale, Conture, & Walden, 2014), and (5) significantly higher emotional reactivity (indexed by mean tonic skin conductance level) during narratives following negative and positive, compared to baseline, emotional stress conditions (Choi, Conture, Walden, Jones, & Kim, 2016). Most recently, researchers have reported that decreased emotion regulation (indexed by decreased parasympathetic activity) is significantly associated with

[1] It is important to note that although the Arnold et al., (2011) empirical study of cortical associates of emotion in CWS reported no significant between group differences in these associates, there are significant differences in methodology between the current ERP study and the Arnold et al. (2011) EEG study.