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Editorial

Introduction to the special issue: Psychophysiology and psychobiology in emotion development

Introduction

Research conducted that evaluates the impact of psychophysiology on emotions in adulthood has expanded during recent years (Davidson, Jackson, & Kalin, 2000; Kemp, Krygier, & Harmon-Jones, 2015; Silvers, Buhle, & Oschner, 2014), but many questions remain about the underpinnings of emotional development in infancy and childhood. Emotions are ubiquitous in development and have been studied from structural, functional and dynamic perspectives. Emotions involve subjective experiences, physiological patterns, and behavioral responses (Fox, Reeb-Sutherland, & Degnan, 2013). Structurally, emotions have traditionally been classified into basic emotions (fear, disgust, anger, surprise, happiness, and sadness) and blended/complex emotions (e.g., shame, guilt, pride) that reportedly require more self-reflection and self-evaluation (Izard et al., 2011). Emotional development also includes experiencing and learning about socioemotional events as well as individual difference in emerging emotional regulatory abilities. Emotion regulation, a pivotal construct across developmental periods, is defined as the ability to respond and adapt to emotional experiences in an age-appropriate manner (Cole, 2014). Experimental developmental psychologists, in particular, advocate for the importance of the role of genes and physiology in the development of emotions.

Recently, epigenetic studies reveal that biological and physiological predispositions in context of early experiences influence the developmental trajectory of both the brain and behavior (Fox, Levitt, & Nelson, 2010; Meaney, 2010). Emotion and emotion regulation are important early experiences. Moreover, Michel (2013) posited that the consideration of epigenetic effects in developmental psychobiology serves to unify psychological perspectives on ontogeny. Although much of this research focuses on animal models, Michel alluded to the importance of applying these ideas to the study of human development. In line with Michel's proposition, we argue that an appreciation of the various underlying physiological substrates of emotional experiences in infancy and childhood is crucial to understanding many aspects of psychological development. Furthermore, understanding of the biological × environmental interaction as well as childhood brain plasticity (Fox, Calkins, & Bell, 1994; Thatcher, 1994) offers the opportunity for potential interventions to redirect children toward optimal emotional development.

The overarching aim of this special issue is to report on some of the psychophysiological and psychobiological methodologies researchers are using to explore and understand the diverse field of emotional development in infants and children. The articles in this special issue are organized according to the types of psychophysiological and psychobiological measures and underlying theories

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the researchers used in their studies. Collectively, these articles highlight how diverse methodologies and theoretical perspectives in the developmental field serve to provide a wealth of information about the physiological foundations and processes within emotional development across infancy and childhood.

Electroencephalography in emotion research during development

One of the most informative neurophysiological measurements used with children and within emotion research is electroencephalography (EEG). EEG measurements can reveal brain functions and maturation (Niedermeyer & Lopes da Silva, 1993), and EEG has the advantage that it is noninvasive. EEG can be used as an individual difference measure, a predictive measure, and a response to specific stimuli measure. These EEG paradigms provide a useful tool in understanding brain processing skills as well as developmental changes across maturation underlying emotion development. Six studies used EEG as a measure in this special issue, half employing EEG power/asymmetry and the other half using evoked response potential (ERP) measures.

EEG power (or activity), in a specific frequency band and in a specific area or regions of the brain, is a measure that examines the characteristics of the EEG waveform within an individual. Levels of power/activation in more anterior regions (Coan & Allen, 2004) have been associated with the specific emotions as well as dispositions or traits (and their maturation across age) (Posner & Rothbart, 2007). Asymmetry, on the other hand, is the relative balance between the two hemispheres (within a brain region). Many who have studied asymmetry discuss the developing communication of the hemispheres across the corpus callosum, especially in more anterior sites like the frontal lobes (Diego, Jones, & Field, 2010; Fox et al., 1994; Jones, Field, Davalos, & Pickens, 1997). Measures of EEG power/activity and asymmetry have been shown to be associated with emotion (Jones, Field, Fox, Davalos, & Gomez, 2001) as well as temperamental differences in emotional functioning in early development and have been used as a predictive measure for later childhood regulatory behaviors (Jones, McFall, & Diego, 2004).

Three studies sought to extend these ideas and examined the longitudinal association between measures of frontal power/activity, asymmetry, and later functioning. In a remarkably informative study, Perry, Swingler, Calkins, and Bell demonstrated a direct relationship between frontal region power scores and infant attention and then also demonstrated how these processes were predictive of emotional regulatory skills. In addition, their findings indicated that the hemispheric region with more power moderated the direction of the emotion regulation, with greater attention and right hemisphere activity associated with more emotion regulation and left hemisphere activity associated with less emotion regulation. In a similar line of work, Smith, Diaz, Day, and Bell used EEG asymmetry measures and negative reactivity in infancy as a predictive measure for individual differences in effortful control, a component of executive functioning skills. They discuss the potentially moderating effect of early experiences with negative affect and frontal EEG asymmetry on regulatory skills. Findings demonstrated that only infants rated as showing greater negative affective experiences and having right frontal EEG asymmetry were found to have lower levels of effortful control in later toddlerhood.

Intriguingly, Brooker, Davidson & Goldsmith took a slightly different view, examining the association between maternal negative affect as impacting the infants' early environment as well as physiological and psychobiological regulation. EEG asymmetry and cortisol measures were collected across contexts as moderating factors between maternal negative emotions in infancy and the later risk for overanxious behaviors in childhood. The findings are impressive, with maternal affect during infancy impacting the slopes of the cortisol and frontal asymmetry across age. Specifically, negative maternal experiences at 9-months predicted different neuropsychobiological patterns and overanxious behaviors in childhood.

In a third use of EEG as a measure associated with emotions across development, three studies employed an evoked response potential measure to understand individual variation in emotional responding, perception, arousal, and regulation. ERP responses are conceptualized as measuring the time-locked patterns of the EEG waves in specific brain regions in response to discrete stimuli. The neural wave patterns, including the site, polarity, degree of deflection, and latency, are acquired in

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