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Special Issue Editorial

Emotion dysregulation and emerging psychopathology: A transdiagnostic, transdisciplinary perspective

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In the past quarter century, emotion dysregulation has emerged as an increasingly important construct for understanding diverse adjustment problems in childhood, adolescence, and adulthood. Emotion dysregulation is now recognized across disciplines and theoretical perspectives as a transdiagnostic feature of various mental health outcomes, and is represented in multiple elements of the Research Domain Criteria matrix (e.g., Beauchaine, 2015; Bradley et al., 2011; McLaughlin, Hatzenbuehler, Mennin, & Nolen-Hoeksema, 2011; National Institute of Mental Health, 2019; Sheppes, Suri, & Gross, 2015). This recognition follows from the observations that (a) one or more forms of dysregulated emotion are observed across all empirically derived structural dimensions of psychopathology, including internalizing disorders, externalizing disorders, and psychotic disorders (see Beauchaine, 2001; Beauchaine & Zisner, 2017; Gross & Jazaieri, 2014; Hostinar & Cicchetti, 2019); (b) emotion dysregulation is a common feature of personality disturbance, and is therefore one of four general criteria for personality disorders (American Psychiatric Association, 2013; Trull, 2012); (c) disrupted top-down modulation of emotional reactivity is observed in many forms of psychopathology, even though functional subdivisions of the prefrontal cortex (PFC) that subserve emotion regulation differ depending on the class of emotion considered (see below; Beauchaine, 2015; Palacios-Barrios & Hanson, 2019); and (d) emotion dysregulation in childhood and adolescence confers prospective vulnerability to psychopathology in adulthood (see Cole, Hall, & Hajal, 2017). Thus, specifying and altering complex transactions through which endogenous vulnerabilities transact with social dynamics to reinforce emotion dysregulation and canalize its neuroplastic substrates is of utmost importance to those who seek to prevent and treat various forms of mental illness (e.g., Beauchaine, Constantino, & Hayden, 2018; Beauchaine, Hinshaw, & Bridge, 2019; Eisenberg et al., 2001; Graziano, Keane, & Calkins, 2010; Thompson & Meyer, 2007).

Genesis of Emotion Dysregulation Research

Burgeoning interest in emotion regulation and dysregulation was initiated in part by a collection of papers published in a 1994 *Monograph of the Society for Research in Child Development* (Fox, 1994a). At the time, most scholars were circumspect about emotion as a topic of scientific inquiry given longstanding proscriptions against studying constructs that were defined exclusively by subjective self-reports. The monograph, which was devoted specifically to development of emotion *regulation*, included a series of articles demonstrating that emotional states can be inferred, quantified, and verified through careful assessment of neurohormonal (Stansbury & Gunnar, 1994), electrophysiological (Dawson, 1994; Fox, 1994b), and cardiovascular function (Porges, Doussard-Roosevelt, & Maiti, 1994). A year later, a special issue of *Development and Psychopathology* appeared in which several prominent scholars contributed articles specifying neurohormonal and psychophysiological correlates of both typical and atypical emotional development (Cicchetti, Ackerman, & Izard, 1995; Hart, Gunnar, & Cicchetti, 1995; Katz & Gottman, 1995; Zahn-Waxler, Cole, Welsh, & Fox, 1995). Soon thereafter, neuroimaging assessment of emotion became mainstream among adults and eventually among children and adolescents (see Cicchetti & Thomas, 2008; Davidson, Jackson, & Kalin, 2000). These developments showed that emotions can be quantified objectively, which rendered emotional processes, including emotion dysregulation, legitimate topics of inquiry. Although addressed in only 37 scientific papers prior to 1994, emotion dysregulation has been the topic of 2,782 articles since (Web of Science, 2019). Most scholars now agree that emotional processes are best captured by research conducted across levels of analyses, including neurobiological, self-report, and behavioral (see Adrian, Zeman, & Veits, 2011; Beauchaine, 2015).

Defining Emotion and Emotion Dysregulation

Scientists who study chronometry and other dynamics of affective experience and expression often distinguish between (a) *emotions*, which are elicited by specific stimuli and events (both endogenous and exogenous), persist from seconds to minutes, and motivate immediate action or inaction; and (b) *moods*, which are imbued by broader internal and external milieus, persist from hours to days and weeks, and bias patterns of cognition and behavior over time (see Fox, 2018). Thus, fluctuations in emotion may influence mood, and mood may bias emotional responses, but mood and emotion are not isomorphic. Although no clear line demarcates emotion from mood, the distinction is nevertheless important for understanding differences between emotional reactions to discrete events (e.g., craving, desire, fear, and sadness)

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versus persistent mood states that transcend immediate situational contexts (e.g., mania, anhedonia, and depression). A practical illustration of the distinction between mood and emotion comes from research on depression, where patients often show *less* negative emotional reactivity to sad stimuli than healthy controls (Rottenberg, 2005). Thus, emotion and mood sometimes fractionate, and mood disturbance is not necessarily attributable to emotion dysregulation (Sheppes et al., 2015).

As is the case for emotion, it is important to define emotion dysregulation carefully. In our own work, we operationalize emotion dysregulation as, "a pattern of emotional experience and/or expression that interferes with appropriate goal-directed behavior" (Beauchaine, 2015, p. 876). This somewhat inclusive definition both follows from and contrasts with situationally functional accounts of emotion regulation, which emphasize emotions as effective initiators, maintainers, and modulators of goal-directed behavior (Campos, Mumme, Kermoian, & Campos, 1994; Cole, Martin, & Dennis, 2004; Thompson, 1990).

Four aspects of our definition of emotion dysregulation are worth elaborating. First, we purposefully emphasize emotion over mood, consistent with distinctions outlined above. Second, our definition is agnostic regarding evolutionary functions of behavior and emotion, and instead refers to "appropriate" goal-directed behavior. In this context, "appropriate" behaviors are those that are *situationally functional* (see, e.g., Ramsook, Cole, & Fields-Olivieri, 2019). For example, well-mannered, emotionally stable behavior in the classroom is situationally functional in Western culture, whereas impulsive and emotionally exuberant behaviors are often viewed as dysfunctional. However, such impulsivity and exuberance were likely not maladaptive in our environments evolutionary adaptation. Such behaviors likely conferred selective advantages in certain environments (see Mead, Beauchaine, & Shannon, 2010). This example illustrates an important difference between situational and evolutionary functionalism. Emotion researchers are sometimes criticized for subscribing to evolutionary functionalism (e.g., Barrett, 2017), when they instead endorse situational functionalism (Beauchaine & Haines, 2019).

Third, situationally functional and dysfunctional behaviors, including expressions of emotion, often differ across cultures. Emotional reactions that are expected in some cultures may be viewed as threatening, undercontrolled, apprehensive, and so on, in others, and thereby evoke reprisals, social rejection, and other consequences that impede goal-directed behavior. The functional value of expressed emotion therefore cannot be assessed independent of cultural context (e.g., Bhugra & McKenzie, 2003; Mauss & Butler, 2010).

Fourth and finally, implicit in our definition is acknowledgment that many emotional reactions are *afunctional*. For example, fairly intense solitarily displays of anger, such as those evoked when one narrowly avoids a traffic accident, may serve no function or dysfunction whatsoever (Beauchaine & Haines, 2019). Thus, whether an emotional reaction is functional, dysfunctional, or afunctional; regulated, dysregulated, or unregulated, often depends on eliciting contextual events, and match or mismatch between context and expressive intensity (Aldao, 2013).

Neural Models of Emotion Dysregulation I: Evolutionary Functionalism

Two competing neural theories of emotion dysregulation follow from separate intellectual traditions. According to the more conventional perspective, broad classes of emotion, including approach (e.g., wanting, enthusiasm), avoidance (e.g., apprehension, fear), and social affiliative (e.g., compassion, affection), evolved to motivate adaptive, survival-related behaviors (e.g., Keltner & Gross, 1999). Evolutionary functionalists propose that subcortical neural circuits subserving approach, avoidance, and social affiliation are preserved across species because they were selected in our environments of adaptation (e.g., Panksepp, 2016). Circuits involved in generating appetitive emotions include the striatum (ventral and dorsal) and its afferent projections from the ventral tegmental area (e.g., Volkow, Wise, & Baler, 2017). In contrast, circuits involved in generating aversive emotions include the septo-hippocampal system and its afferent projections from the amygdala (see Corr, 2013; Strange, Witter, Lein, & Moser, 2014).

Over 50 years of comparative research with animals and humans has yielded general agreement regarding principal functions of these circuits in mediating approach and avoidance emotions and motivating approach and avoidance behaviors (see Beauchaine & Zisner, 2017). It should be noted, however, that subcortical neural systems are structurally interconnected and functionally interdependent (see Beauchaine & Constantino, 2017; Beyeler, 2016; Corr, 2013). For example, the nucleus accumbens (a ventral striatal structure) and the amygdala share interconnections via the paraventricular nucleus and the stria terminalis (e.g., Dong, Li, & Kirouac, 2017). Furthermore, the nucleus accumbens responds to punishment as well as reward, and the amygdala responds to reward as well as punishment (see, e.g., Sauder, Derbidge, & Beauchaine, 2016; Schultz, 2016). Functional specificity of approach and avoidance circuits is therefore relative, not categorical.

According to the traditional perspective, humans behave at the behest of their emotions in life-threatening situations and other survival-relevant contexts (e.g., when one's children are in danger or when food is scarce). In contrast, given highly elaborated PFCs, humans can suppress emotional responses and engage in more deliberative actions when doing so is deemed advantageous. In such situations, subcortical circuits that subserve emotion-generating functions are modulated by cortical circuits that subserve emotion-regulating functions. This interpretation is consistent with literature linking top-down prefrontal and orbitofrontal control to executive function, self-regulation, and emotion regulation (e.g., Beauchaine, 2015; Etkin, Büchel, & Gross, 2015; Heatherton, 2011; Zelazo, 2015). Dozens of neuroimaging studies show increased activation in functional subdivisions of the prefrontal, anterior cingulate, and insular cortices during volitional downregulation of negative affect (see, e.g., Tone, Garn, & Pine, 2016; Zilverstand, Parvaz, & Goldstein, 2017).

Similarly, effortful reappraisal of negative emotion yields patterns of responding across a distributed network of prefrontal structures (Goldin, McRae, Ramel, & Gross, 2008). Poor top-down functional connectivity between these structures and subcortical regions implicated in generating approach and avoidance emotions is observed in externalizing and internalizing disorders, respectively (Gold et al., 2016; Korponay et al., 2017; Kujawa et al., 2016; Qing et al., 2012; Shannon, Sauder, Beauchaine, & Gatzke-Kopp, 2009). Moreover, emotional lability is associated with poor top-down control of the amygdala by the medial PFC and reduced functional connectivity between the amygdala and the orbitofrontal cortex (Churchwell, Morris, Heurtelou, & Kesner, 2009; Hilt, Hanson, & Pollak, 2011). Collectively, these findings support the notion that emotion dysregulation derives

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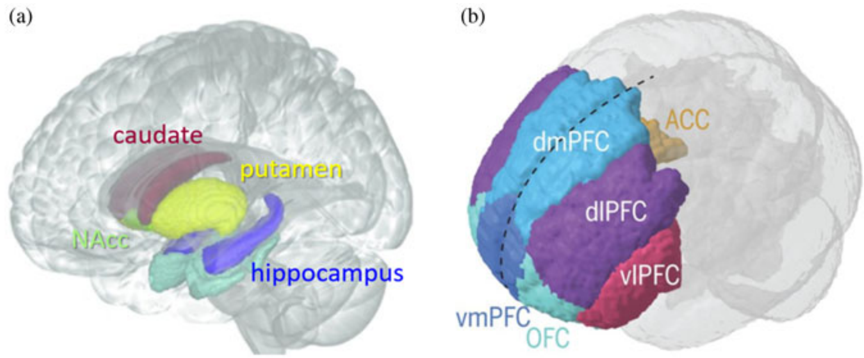

Figure 1. (a) Subcortical and (b) cortical neural structures implicated in emotion generation and emotion regulation. Panel a shows the nucleus accumbens (NAcc), part of the ventral striatum; the caudate nucleus and putamen, parts of the dorsal striatum; and the hippocampus, part of the septo-hippocampal system. The amygdala (not pictured) is a small neural structure positioned at the anterior (forward) face of the hippocampus. Adapted with permission from Krishnan, Watkins, and Bishop (2016). Panel b shows functional subdivisions of the prefrontal cortex, including the anterior cingulate cortex (ACC), the dorsomedial prefrontal cortex (PFC), the dorsolateral PFC, the ventrolateral PFC, the ventromedial PFC, and the orbitofrontal cortex (OFC). Adapted with permission from Carlén (2017).

at least in part from inadequate prefrontal modulation of subcortical neural responding. Subcortical and cortical neural structures implicated in emotion generation and emotion regulation are depicted in Figure 1.

Neural Models of Emotion Dysregulation II: Constructionism

More recently, constructionist models of emotion dysregulation have been described (Barrett, Wilson-Mendenhall, & Barsalou, 2013; Leshin & Lindquist, 2019). In general, constructionists eschew the notion that emotions serve evolutionary functions, and question the value of comparative animal research for making inferences about human emotion and behavior (e.g., Barrett, 2017; Barrett et al., 2013). Constructionists sometimes argue that emotions are distinctly human experiences without homologues in the broader animal kingdom (Leshin & Lindquist, 2019). According to this perspective, experiential states including perception, cognition, and emotion arise from interactions among sensory and neural processes, which humans interpret and categorize based on learning and prior experience (see Barrett, 2009). Constructionist theory specifies *core affective processes*, which transcend various emotional states. In contrast to specific emotions (e.g., sadness, anger, and fear), core affective processes are more general, and include valence (positivity–negativity) and arousal (activation–deactivation). Through recurrent pairings of core affective processes with neural, sensory, and perceptual inputs from our environments, we come to associate core affect with higher order representations of specific emotions (Russell & Barrett, 1999). Neural substrates of core affective processes are presumed to be universal among humans, present at birth, and dependent on the same circuits as decision making and other psychological processes (Duncan & Barrett, 2007).

Constructionist theories have garnered considerable attention in recent years (see Barrett, 2017; Leshin & Lindquist, 2019), and now rival functionalist perspectives as explanatory models of emotion. To date, however, constructionists have written relatively little about emotion dysregulation (Beauchaine & Haines, 2019). This is likely because constructionists view emotions as emergent properties of complex neural systems. Emotions are therefore by-products of highly individualized, experience-dependent neural response patterns. Each person's unique learning history confers cognitive-affective schemas, attributional biases, and stimulus-response associations that contribute to emotional experience and expression. Thus, emotion and emotion dysregulation are not differentiable because they arise from the same idiosyncratic learning histories and neural processes (see Papa & Epstein, 2018).

More specifically, constructionists argue that emotion dysregulation arises from the same neural processes as core affect (e.g., valence and arousal), combined with disruptions in *situated conceptualization* (Barrett et al., 2013). This refers to "the brain [as] a situated processing architecture, designed to process situations in the moment and to simulate non-present situations in thought" (Barsalou, 2016, p. 6), including assessment of what immediate events represent, deciding how to act upon such events, and predicting what core affective processes to expect as a consequence. Emotion dysregulation could arise from highly routinized conceptualizations that are not situation dependent (Barrett et al., 2013). Nonsituational conceptualizations may stem from disrupted memory function, altered autonomic regulation, or poor attention deployment, among other processes. These and other deficits correlate with disrupted intrinsic neural network connectivity in the salience network and the frontoparietal network, as seen in diverse forms of psychopathology (Barrett & Satpute, 2013). Thus, although specific foci differ across functionalist and constructionist perspectives, both emphasize connectivity deficits toward explaining emotion dysregulation. Moreover, situational functionalism and constructionism both emphasize the importance of context in shaping and interpreting emotion (see Beauchaine & Haines, 2019).

Neurodevelopmental Considerations

An important consideration for any developmental theory of emotion dysregulation concerns differential neuromaturation of subcortical structures depicted in Figure 1a versus cortical structures depicted in Figure 1b. Neurodevelopment of the PFC lags several years behind neurodevelopment of subcortical structures (Brain Development Cooperative Group, 2012; Casey, Getz, & Galvan, 2008; see also Hauser, Will, Dubois, & Dolan, 2019). As outlined previously, PFC neuromaturation is critical to efficient executive function, self-regulation, and emotion regulation (e.g., Beauchaine & Zisner, 2017; Palacios-Barrios & Hanson, 2019; Zelazo, 2015). Improvements in self-regulation across development occur in part through more efficient top-down modulation of subcortical structures by functional subdivisions of the PFC, and improved connectivity between subcortical structures and the PFC (see Casey, Oliveri, & Insel, 2014; Swartz, Carrasco, Wiggins, Thomason, & Monk, 2014). When exposed to emotion-eliciting events, typically developing children exhibit stronger subcortical responses but weaker and more diffuse frontal responses than adults (Macdonald, Goines, Novacek, & Walker, 2016). Normal PFC neuromaturation yields increasingly effective top-down regulation of these strong subcortical responses (e.g., Arnsten & Rubia, 2012).

Although specific neural structures differ across disorders, neurodevelopment of the PFC, and efficiency of subcortical–cortical

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connections, become increasingly compromised for many adolescents with both internalizing and externalizing disorders (e.g., De Brito et al., 2009; Gold et al., 2016; Shaw et al., 2012). Adolescent boys with attention-deficit/hyperactivity and conduct disorder, for example, exhibit reduced anterior cingulate cortex volumes, which co-occur with disrupted connectivity between the anterior cingulate cortex and the striatum (Sauder, Beauchaine, Gatzke-Kopp, Shannon, & Aylward, 2009; Shannon et al., 2009). These findings and others that we have insufficient space to discuss suggest that both internalizing and externalizing progression across development derive at least in part from failures in neuromaturation of prefrontal regions implicated in executive function, self-regulation, and emotion regulation (for recent reviews, see Beauchaine, Zisner, & Hayden, 2019; Cubillo, Halari, Smith, Taylor, & Rubia, 2012). An ever-expanding body of research shows that frontal neuromaturation and cortical–subcortical connectivity are exquisitely sensitive to environmental insults including risk factors that accrue with poverty and heavy substance use (e.g., Hair, Hanson, Wolfe, & Pollak, 2015; Nguyen-Louie et al., 2018; Palacios-Barrios & Hanson, 2019; Pfefferbaum et al., 2018). Environmental effects on frontal neuromaturation begin in infancy (Hanson et al., 2013), which suggests a clear need for expanded prevention and early intervention programs.

Conclusion

We hope this editorial serves as a useful introduction to the Special Issue. We received exceedingly strong transdisciplinary contributions, both empirical and theoretical, from some of the field's top emotion researchers. We believe papers in the volume advance emotion dysregulation research, and will serve as a springboard for future studies. We are therefore eager to share these papers with the readership of *Development and Psychopathology*.

References

Adrian, M., Zeman, J., & Veits, G. (2011). Methodological implications of the affect revolution: A 35-year review of emotion regulation assessment in children. *Journal of Experimental Child Psychology*, *110*, 171–197. doi:10.1016=j.jecp.2011.03.009

Aldao, A. (2013). The future of emotion regulation research: Capturing context. *Perspectives on Psychological Science*, *8*, 155–172. doi:10.1177/1745691612459518

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: Author.

Arnsten, A. F. T., & Rubia, K. (2012). Neurobiological circuits regulating attention, cognitive control, motivation, and emotion: Disruptions in neurodevelopmental psychiatric disorders. *Journal of the American Academy of Child & Adolescent Psychiatry*, *51*, 356–367. doi:10.1016/j.jaac.2012.01.008

Barrett, L. F. (2009). The future of psychology: Connecting mind to brain. *Perspectives on Psychological Science*, *4*, 326–339. doi:10.1111/j.1745-6924.2009.01134.x

Barrett, L. F. (2017). Functionalism cannot save the classical view of emotion. *Social Cognitive and Affective Neuroscience*, *12*, 34–36. doi:10.1093/scan/nsw156

Barrett, L. F., & Satpute, A. (2013). Large-scale brain networks in affective and social neuroscience: Towards an integrative architecture of the human brain. *Current Opinion in Neurobiology*, *23*, 1–12. doi:10.1016/j.conb.2012.12.012

Barrett, L. F., Wilson-Mendenhall, C. D., & Barsalou, L. W. (2013). A psychological construction account of emotion regulation and dysregulation: The role of situated conceptualizations. In J. J. Gross (Ed.), *Handbook of emotion regulation* (2nd ed., pp. 447–465). New York: Guilford Press.

Barsalou, L. W. (2016). Situated conceptualization offers a theoretical account of social priming. *Current Opinion in Psychology*, *12*, 6–11. doi:10.1016/j.copsyc.2016.04.009

Beauchaine, T. P. (2001). Vagal tone, development, and Gray's motivational theory: Toward an integrated model of autonomic nervous system functioning in psychopathology. *Development and Psychopathology*, *13*, 183–214. doi:10.1017/S0954579401002012

Beauchaine, T. P. (2015). Future directions in emotion dysregulation and youth psychopathology. *Journal of Clinical Child and Adolescent Psychology*, *44*, 875–896. doi:10.1080/15374416.2015.1038827

Beauchaine, T. P., & Constantino, J. N. (2017). Redefining the endophenotype concept to accommodate transdiagnostic vulnerabilities and etiological complexity. *Biomarkers in Medicine*, *11*, 769–780. doi:10.221/bmm-2017-0002

Beauchaine, T. P., Constantino, J. N., & Hayden, E. P. (2018). Psychiatry and developmental psychopathology: Unifying themes and future directions. *Comprehensive Psychiatry*, *87*, 143–152. doi:10.1016/j.comppsych.2018.10.014

Beauchaine, T. P., & Haines, N. (2019). Functionalist and constructionist perspectives on emotion dysregulation. In T. P. Beauchaine & S. E. Crowell (Eds.), *The Oxford handbook of emotion dysregulation*. New York: Oxford University Press.

Beauchaine, T. P., Hinshaw, S. P., & Bridge, J. A. (2019). Nonsuicidal self-injury and suicidal behaviors in girls: The case for targeted prevention in preadolescence. *Clinical Psychological Science*. Advance online publication. doi:10.1177/2167702618818474

Beauchaine, T. P., & Zisner, A. (2017). Motivation, emotion regulation, and the latent structure of psychopathology: An integrative and convergent historical perspective. *International Journal of Psychophysiology*, *119*, 108–118. doi:10.1016/j.ijpsycho.2016.12.014

Beauchaine, T. P., Zisner, A. R., & Hayden, E. P. (2019). Neurobiological mechanisms of psychopathology and treatment action. In T. H. Ollendick, S. W. White, & B. A. White (Eds.), *The Oxford handbook of clinical child and adolescent psychology* (pp. 699–723). New York: Oxford University Press.

Beyeler, A. (2016). Parsing reward from aversion. *Science*, *354*, 558. doi:10.1126/science.aak9762

Bhugra, D., & McKenzie, K. (2003). Expressed emotion across cultures. *Advances in Psychiatric Treatment*, *9*, 342–348. doi:10.1192/apt.9.5.342

Bradley, B., DeFife, J. A., Guarnaccia, C., Phifer, J., Fani, N., Ressler, K. J., & Westen, D. (2011). Emotion dysregulation and negative affect: Association with psychiatric symptoms. *Journal of Clinical Psychiatry*, *72*, 685–691. doi:10.4088/JCP.10m06409blu

Brain Development Cooperative Group. (2012). Total and regional brain volumes in a population-based normative sample from 4 to 18 years: The NIH MRI study of normal brain development. *Cerebral Cortex*, *22*, 1–12. doi:10.1093/cercor/bhr018

Campos, J. J., Mumme, D. L., Kermoian, R., & Campos, R. G. (1994). A functionalist perspective on the nature of emotion. *Monographs of the Society for Research on Child Development*, *59*, 284–303. doi:10.1111/j.1540-5834.1994.tb01289.x

Carlén, M. (2017). What constitutes the prefrontal cortex? *Science*, *358*, 478–482. doi:10.1126/science.aan8868

Casey, B. J., Getz, S., & Galvan, A. (2008). The adolescent brain. *Developmental Review*, *28*, 62–77. doi:10.1016/j.dr.2007.08.003

Casey, B. J., Oliveri, M. E., & Insel, T. (2014). A neurodevelopmental perspective on the Research Domain Criteria (RDoC) framework. *Biological Psychiatry*, *76*, 350–353. doi:10.1016/j.biopsych.2014.01.006

Churchwell, J. C., Morris, A. M., Heurtelou, N. M., & Kesner, R. P. (2009). Interactions between the prefrontal cortex and amygdala during delay discounting and reversal. *Behavioral Neuroscience*, *123*, 1185–1196. doi:10.1037/a0017734

Cicchetti, D., Ackerman, B. P., & Izard, C. E. (1995). Emotions and emotion regulation in developmental psychopathology. *Development and Psychopathology*, *7*, 1–10. doi:10.1017/S0954579400006301

Cicchetti, D., & Thomas, K. M. (2008). Imaging brain systems in normality and psychopathology. *Development and Psychopathology*, *20*, 1023–1027. doi.org/10.1017/S0954579408000485

https://doi.org/10.1017/S0954579419000671 Published online by Cambridge University Press

Cole, P. M., Hall, S. E., & Hajal, N. (2017). Emotion dysregulation as a vulnerability to psychopathology. In T. P. Beauchaine & S. P. Hinshaw (Eds.), *Child and adolescent psychopathology* (3rd ed., pp. 346–386). Hoboken, NJ: Wiley.

Cole, P. M., Martin, S. E., & Dennis, T. A. (2004). Emotion regulation as a scientific construct: Methodological challenges and directions for child development research. *Child Development*, *75*, 317–333. doi:10.1111/j.1467-8624.2004.00673.x

Corr, P. J. (2013). Approach and avoidance behaviour: Multiple systems and their interactions. *Emotion Review*, *5*, 285–290. doi:10.1177/1754073913477507

Cubillo, A., Halari, R., Smith, A., Taylor, E., & Rubia, K. (2012). A review of fronto-striatal and fronto-cortical brain abnormalities in children and adults with ADHD and new evidence for dysfunction in adults with ADHD during motivation and attention. *Cortex*, *48*, 194–215. doi:10.1016/j.cortex.2011.04.007

Davidson, R. J., Jackson, D. C., & Kalin, N. H. (2000). Emotion, plasticity, context, and regulation: Perspectives from affective neuroscience. *Psychological Bulletin*, *126*, 890–909. doi:10.1037/0033-2909.126.6.890

Dawson, G. (1994). Frontal electroencephalographic correlates of individual differences in emotion expression in infants: A brain systems perspective on emotion. *Monographs of the Society for Research in Child Development*, *59*, 135–151. doi:10.1111/1540-5834.ep9502132768

De Brito, S. A., Mechelli, A., Wilke, M., Laurens, K. R., Jones, A. P., Barker, G. J., … Viding, E. (2009). Size matters: Increased grey matter in boys with conduct problems and callous–unemotional traits. *Brain*, *132*, 843–852. doi:10.1093/brain/awp011

Dong, X., Li, S., & Kirouac, G. J. (2017). Collateralization of projections from the paraventricular nucleus of the thalamus to the nucleus accumbens, bed nucleus of the stria terminalis, and central nucleus of the amygdala. *Brain Structure and Function*, *222*, 3927–3943. doi:10.1007/s00429-017-1445-8

Duncan, S., & Barrett, L. F. (2007). Affect is a form of cognition: A neurobiological analysis. *Cognition and Emotion*, *21*, 1184–1211. doi:10.1080/02699930701437931

Eisenberg, N., Losoya, S., Fabes, R. A., Guthrie, I. K., Reiser, M., Murphy, B., … Padgett, S. J. (2001). Parental socialization of children's dysregulated expression of emotion and externalizing problems. *Journal of Family Psychology*, *15*, 183–205. doi:10.1037/0893-3200.15.2.183

Etkin, A., Büchel, C., & Gross, J. J. (2015). The neural bases of emotion regulation. *Nature Reviews Neuroscience*, *16*, 693–700. doi:10.1038/nrn4044

Fox, E. (2018). Perspectives from affective science on understanding the nature of emotion. *Brain and Neuroscience Advances*, *2*, 1–8. doi:10.1177/2398212818812628

Fox, N. A. (Ed.) (1994a). The development of emotion regulation: Biological and behavioral considerations. *Monographs of the Society for Research in Child Development*, *59*, 101–136.

Fox, N. A. (1994b). Dynamic cerebral processes underlying emotion regulation. *Monographs of the Society for Research in Child Development*, *59*, 152–166. doi:10.1111/j.1540-5834.1994.tb01282.x

Gold, A. L., Shechner, T., Farber, M. J., Spiro, C. N., Leibenluft, E., Pine, D. S., & Britton, J. C. (2016). Amygdala-cortical connectivity: Associations with anxiety, development, and threat. *Depression and Anxiety*, *33*, 917–926. doi:10.1002/da.22470

Goldin, P. R., McRae, K., Ramel, W., & Gross, J. J. (2008). The neural bases of emotion regulation: Reappraisal and suppression of negative emotion. *Biological Psychiatry*, *63*, 577–586. doi:10.1016/j.biopsych.2007.05.031

Graziano, P., Keane, S. P., & Calkins, S. D. (2010). Maternal behaviour and children's early emotion regulation skills differentially predict development of children's reactive control and later effortful control. *Infant and Child Development*, *19*, 333–353. doi:10.1002/icd.670

Gross, J. J., & Jazaieri, H. (2014). Emotion, emotion regulation, and psychopathology: An affective science perspective. *Clinical Psychological Science*, *2*, 387–401. doi:10.1177/2167702614536164

Hair, N. L., Hanson, J. L., Wolfe, B. L., & Pollak, S. D. (2015). Association of child poverty, brain development, and academic achievement. *JAMA Pediatrics*, *169*, 822–829. doi:10.1001/jamapediatrics.2015.1475

Hanson, J. L., Hair, N., Shen, D. G., Shi, F., Gilmore, J. H., Wolfe, B. L., & Pollak, S. D. (2013). Family poverty affects the rate of human infant brain growth. *PLOS ONE*, *8*, e80954. doi:0.1371/journal.pone.0080954

Hart, J., Gunnar, M., & Cicchetti, D. (1995). Salivary cortisol in maltreated children: Evidence of relations between neuroendocrine activity and social competence. *Development and Psychopathology*, *7*, 11–26. doi:10.1017/S0954579400006313

Hauser, T. U., Will, G.-J., Dubois, M., & Dolan, R. J. (2019). Annual Research Review: Developmental computational psychiatry. *Journal of Child psychology and Psychiatry*. Advance online publication. doi:10.1111/jcpp.12964

Heatherton, T. F. (2011). Neuroscience of self and self-regulation. *Annual Review of Psychology*, *62*, 363–390. doi:10.1146/annurev.psych.121208.131616

Hilt, L. M., Hanson, J. L., & Pollak, S. D. (2011). Emotion dysregulation. In B. B. Brown & M. J. Prinstein (Eds.), *Encyclopedia of adolescence* (Vol. 3, pp. 160–169). New York: Elsevier.

Hostinar, C. E., & Cicchetti, D. (2019). Emotion dysregulation and internalizing spectrum disorders. In T. P. Beauchaine & S. E. Crowell (Eds.), *The Oxford handbook of emotion dysregulation*. New York: Oxford University Press.

Katz, L. F., & Gottman, J. M. (1995). Vagal tone protects children from marital conflict. *Development and Psychopathology*, *7*, 88–92. doi:10.1017/S0954579400006350

Keltner, D., & Gross, J. J. (1999). Functional accounts of emotions. *Cognition and Emotion*, *13*, 467–480. doi:10.1080/026999399379140

Korponay, C., Pujara, M., Deming, P., Philippi, C., Decety, J., Kosson, D. S., … Koenigs, M. (2017). Impulsive-antisocial dimension of psychopathy linked to enlargement and abnormal functional connectivity of the striatum. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, *2*, 149–157. doi:10.1016/j.bpsc.2016.07.004

Krishnan, S., Watkins, K. E., & Bishop, D. V. M. (2016). Neurobiological basis of language learning difficulties. *Trends in Cognitive Sciences*, *20*, 701–714. doi:10.1016/j.tics.2016.06.012

Kujawa, A., Wu, M., Klumpp, H., Pine, D. S., Swain, J. E., Fitzgerald, K. D., … Phan, K. L. (2016). Altered development of amygdala-anterior cingulate cortex connectivity in anxious youth and young adults. *Biological Psychiatry Cognition Neuroscience Neuroimaging*, *1*, 345–352. doi:10.1016/j.bpsc.2016.01.006

Leshin, J. C., & Lindquist, K. A. (2019). Neuroimaging of emotion dysregulation. In T. P. Beauchaine & S. E. Crowell (Eds.), *The Oxford handbook of emotion dysregulation*. New York: Oxford University Press.

Macdonald, A., Goines, K., Novacek, E., & Walker, E. (2016). Prefrontal mechanisms of comorbidity from a transdiagnostic and ontogenic perspective *Development and Psychopathology*, *28*, 1147–1175. doi:10.1017/S0954579416000742

Mauss, I. B., & Butler, E. A. (2010). Cultural context moderates the relationship between emotion control values and cardiovascular challenge versus threat responses. *Biological Psychology*, *84*, 521–530. doi:10.1016/j.biopsycho.2009.09.010

McLaughlin, K. A., Hatzenbuehler, M. L., Mennin, D. S., & Nolen-Hoeksema, S. (2011). Emotion dysregulation and adolescent psychopathology: A prospective study. *Behavior Research and Therapy*, *49*, 544–554. doi:10.1016/j.brat.2011.06.003

Mead, H. K., Beauchaine, T. P., & Shannon, K. E. (2010). Neurobiological adaptations to violence across development. *Development and Psychopathology*, *22*, 1–22. doi:10.1017/S0954579409990228

National Institute of Mental Health. (2019). *Research Domain Criteria matrix*. Retrieved March 25, 2019, from https://www.nimh.nih.gov/research/research-funded-by-nimh/rdoc/constructs/rdoc-matrix.shtml

Nguyen-Louie, T. T., Simmons, A. N., Squeglia, L. M., Alejandra Infante, M., Schacht, J. P., & Tapert, S. F. (2018). Earlier alcohol use onset prospectively predicts changes in functional connectivity. *Psychopharmacology*, *235*, 1041–1054. doi:10.1007/s00213-017-4821-4

Palacios-Barrios, E. E., & Hanson, J. L. (2019). Poverty and self-regulation: Connecting psychosocial processes, neurobiology, and the risk for psychopathology. *Comprehensive Psychiatry*, *90*, 52–64. doi:10.1016/j.comppsych.2018.12.012

Panksepp, J. (2016). The psycho-neurology of cross-species affective/social neuroscience: Understanding animal affective states as a guide to development of novel psychiatric treatments. *Current Topics in Behavioral Neuroscience*, *30*, 109–125. doi:10.1007/7854_2016_458

https://doi.org/10.1017/S0954579419000671 Published online by Cambridge University Press

Papa, A., & Epstein, E. (2018). Emotions and emotion regulation. In S. C. Hayes & S. G. Hofmann (Eds.), *Process-based CBT* (pp. 137–152). Oakland, CA: New Harbinger.

Pfefferbaum, A., Kwon, D., Brumback, T., Thompson, W. K., Cummins, K., Tapert, S. F., … Sullivan, E. V. (2018). Altered brain developmental trajectories in adolescents after initiating drinking. *American Journal of Psychiatry*, *175*, 370–380. doi:10.1176/appi.ajp.2017.17040469

Porges, S. W., Doussard-Roosevelt, J. A., & Maiti, A. K. (1994). Vagal tone and the physiological regulation of emotion. *Monographs of the Society for Research on Child Development*, *59*, 167–186. doi:10.1111/1540-5834.ep9502132771

Qing, L., Haoran, L., Luo, G., Wang, Y., Tang, H., Han, L., & Yao, Z. (2012). Impaired prefrontal-amygdala effective connectivity is responsible for the dysfunction of emotion process in major depressive disorder: A dynamic causal modeling study on MEG. *Neuroscience Letters*, *523*, 125–130. doi:10.1016/j.neulet.2012.06.058

Ramsook, K. A., Cole, P. M., & Fields-Olivieri, M. A. (2019). What emotion dysregulation looks like: Inferences from behavioral observations. In T. P. Beauchaine & S. E. Crowell (Eds.), *The Oxford handbook of emotion dysregulation*. New York: Oxford University Press.

Rottenberg, J. (2005). Mood and emotion in major depression. *Current Directions in Psychological Science*, *14*, 167–170. doi:10.1111/j.0963-7214.2005.00354.x

Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology*, *76*, 805–819. doi:10.1037/0022-3514.76.5.805

Sauder, C. L., Beauchaine, T. P., Gatzke-Kopp, L. M., Shannon, K. E., & Aylward, E. (2009). Neuroanatomical correlates of heterotypic comorbidity in externalizing male adolescents. *Journal of Clinical Child and Adolescent Psychology*, *41*, 346–352. doi:10.1080/15374416.2012.658612

Sauder, C. L., Derbidge, C. M., & Beauchaine, T. P. (2016). Neural responses to monetary incentives among self-injuring adolescent girls. *Development and Psychopathology*, *28*, 277–291. doi:10.1017/S0954579415000449

Schultz, W. (2016). Dopamine reward prediction-error signaling: A two-component response. *Nature Reviews Neuroscience*, *7*, 183–195. doi:10.1038/nrn.2015.26

Shannon, K. E., Sauder, C., Beauchaine, T. P., & Gatzke-Kopp, L. (2009). Disrupted effective connectivity between the medial frontal cortex and the caudate in adolescent boys with externalizing behavior disorders. *Criminal Justice and Behavior*, *36*, 1141–1157. doi:10.1177/0093854809342856

Shaw, P., Malek, M., Watson, B., Sharp, W., Evans, A., & Greenstein, D. (2012). Development of cortical surface area and gyrification in ADHD. *Biological Psychiatry*, *72*, 191–197. doi:10.1016/j.biopsych.2012.01.031

Sheppes, G., Suri, G., & Gross, J. J. (2015). Emotion regulation and psychopathology. *Annual Review of Clinical Psychology*, *11*, 379–405. doi:10.1146/annurev-clinpsy-032814-112739

Stansbury, K., & Gunnar, M. R. (1994). Adrenocortical activity and emotion regulation. *Monographs of the Society for Research in Child Development*, *59*, 108–134. doi:10.1111/1540-5834.ep9502132766

Strange, B. A., Witter, M. P., Lein, E. S., & Moser, E. I. (2014). Functional organization of the hippocampal longitudinal axis. *Nature Reviews Neuroscience*, *15*, 655–669. doi:10.1038/nrn3785

Swartz, J. R., Carrasco, M., Wiggins, J. L., Thomason, M. E., & Monk, C. S. (2014). Age-related changes in the structure and function of prefrontal cortex–amygdala circuitry in children and adolescents: A multi-modal imaging approach. *NeuroImage*, *86*, 212–220. doi:10.1016/j.neuroimage.2013.08.018

Thompson, R. A. (1990). Emotion and self-regulation. In R. A. Thompson (Ed.), *Nebraska Symposium on Motivation: Vol. 36. Socioemotional development* (pp. 383–483). Lincoln, NE: University of Nebraska Press.

Thompson, R. A., & Meyer, S. (2007). Socialization of emotion regulation in the family. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 249–268). New York: Guilford Press.

Tone, E. B., Garn, C. L., & Pine, D. S. (2016). Anxiety regulation: A developmental psychopathology perspective. In D. Cicchetti (Ed.), *Developmental psychopathology: Vol. 2. Developmental neuroscience* (3rd ed., pp. 523–556). Hoboken, NJ: Wiley.

Trull, T. J. (2012). The Five-Factor Model of Personality Disorder and *DSM*-5. *Journal of Personality*, *80*, 1697–1720. doi:10.1111/j.1467-6494.2012.00771.x

Volkow, N., Wise, R. A., & Baler, R. (2017). The dopamine motive system: Implications for drug and food addiction. *Nature Reviews Neuroscience*, *18*, 741–752. doi:10.1038/nrn.2017.130

Web of Science. (2019). *Citation report for 2,819 results from Web of Science Core Collection between 1900 and 2019*. Retrieved March 24, 2019, from https://clarivate.com/products/web-of-science/

Zahn-Waxler, C., Cole, P. M., Welsh, J. D., & Fox, N. A. (1995). Psychophysiological correlates of empathy and prosocial behaviors in preschool children with behavior problems. *Development and Psychopathology*, *7*, 27–48. doi:10.1017/S0954579400006325

Zelazo, P. D. (2015). Executive function: Reflection, iterative reprocessing, complexity, and the developing brain. *Developmental Review*, *38*, 55–68. doi:10.1016/j.dr.2015.07.001

Zilverstand, A., Parvaz, M. A., & Goldstein, R. Z. (2017). Neuroimaging cognitive reappraisal in clinical populations to define neural targets for enhancing emotion regulation. *A systematic review*. NeuroImage, *151*, 105–116. doi:10.1016/j.neuroimage.2016.06.009

https://doi.org/10.1017/S0954579419000671 Published online by Cambridge University Press