

**Afterword: What are the dimensions and bases for lasting individual differences in emotion?**

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Humans and other animals show enduring individual differences in a range of positive and negative emotions (Boissy, 1995; Gosling, 2008). These emotional traits lie at the core of childhood temperament and adult personality (Caspi, Roberts, & Shiner, 2005; N. A. Fox, Henderson, Marshall, Nichols, & Ghera, 2005; Goldsmith, 1994; Goldsmith et al., 1987; Gray & McNaughton, 2000; Shiner et al., 2012; Shiner & DeYoung, 2013) and there is compelling evidence that they exert a profound influence on health, wealth, and wellbeing across the lifespan (Lahey, 2009; Moffitt, Poulton, & Caspi, 2013; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007; Shackman, Kaplan, et al., 2016; Shackman, Tromp, et al., 2016). In Question 2, we asked the contributors to address the distinction between emotions and temperament. Here, we focused on a closely related question: *How are emotional traits structured and what mechanisms underlie them?*

### **The Nature of Emotional Traits**

All of the authors seem to agree that emotional traits constitute stable, but not immutable, biases in the likelihood of experiencing and expressing particular emotions. For Shackman et al., they represent diatheses that serve to increase the likelihood, magnitude, or duration of emotional responses in the presence of a trait-relevant challenge (e.g., threat for fear). Shiner stakes out a similar position, while Davidson underscores the importance of finer-grained response parameters, including variation in the time-to-peak and return-to-baseline ('recovery'). Shiner, Kagan, and Shackman et al. suggest that emotional traits first emerge in infancy, but continue to evolve for many years as a consequence of learning, experience, and changes in biology (i.e., more slowly developing biological systems mature and come on-line). While acknowledging that the correspondence between emotional traits in childhood and adulthood is imperfect, Shiner and Kagan emphasize significant continuity across the lifespan, with Shiner noting that early emotional tendencies become more complex across development and can influence the development of related cognitive styles (e.g., hopelessness, worry, self-esteem).

Shiner and Davidson tell us that emotional traits encompass individual differences in emotion regulation as well as reactivity (see Question 7). Building on work by Rothbart and her colleagues (Rothbart, 1994, 2011), Shiner argues that trait-like differences in attention, inhibition, and other aspects of *Effortful Control* play a key role in governing emotional responses, while Davidson suggests that deficits in these regulatory processes can contribute to the development of psychopathology (see also Stanton, Rozek, Stasik, Ellickson-Larew, & Watson, 2016).

### **The Structure of Emotional Traits**

Shiner and Shackman et al. agree that emotional traits are structured hierarchically, with broader traits, like *Negative Emotionality/Neuroticism*, subsuming narrower facets (e.g., fear, anger, sadness). Shiner provides the most comprehensive description of how emotional traits are structured. Drawing on decades of factor-analytic work, she highlights the utility of a five-factor ('Big 5') model encompassing the traits of *Positive Emotionality/Extraversion*, *Negative Emotionality/Neuroticism*, *Effortful Control/Conscientiousness*, *Agreeableness*, and *Openness* (Caspi et al., 2005). *Agreeableness* includes tendencies to be considerate, kind, generous, compliant, and, especially later in development, empathic. *Openness* encompasses tendencies to be curious, artistic, and interested in intellectual matters and aesthetics. While acknowledging that *Agreeableness* and *Openness* lack clear counterparts in the temperament literature, Shiner argues that all five dimensions reflect early-emerging emotional tendencies. Kagan focuses on evidence that infants can be classified into those with a 'high-reactive' or a 'low-reactive' temperament (N. A. Fox et al., 2005; Kagan, 1997). He seems to suggest that these temperaments are sculpted by experience to form the emotional core ('anima') of *Negative Emotionality/Neuroticism* and *Positive Emotionality/Extraversion*, respectively. Shackman et al. narrowly focus their response on aspects of *Negative Emotionality/Neuroticism* ('Dispositional Negativity'). Davidson largely eschews traditional, factor-analytically-derived dimensions, instead focusing on traits derived from several decades of psychophysiological and imaging research, mostly by his own group (e.g.,

*Resilience, Positive Outlook, Sensitivity to Context, and Interoceptive Accuracy*) (Davidson & Begley, 2012). Although much less is known about these novel traits, they have the virtue of being derived directly from measures of the nervous system, rather than from pre-existing nosologies or the covariance structure of external indicators, such as introspective ratings or behavior (Davidson, 2001).

## **The Bases of Emotional Traits**

### ***Genetic and Experiential***

Shiner, Kagan, and Shackman et al. seem to agree that emotional traits reflect the dynamic interaction of genetic and experiential mechanisms. Kagan notes that culture and exposure to early adversity (e.g., poverty, exposure to violence) can have a lasting impact on emotional reactivity and mood. Shackman et al. tell us that *Negative Emotionality/Neuroticism* is increased by stress and decreased by treatments for anxiety and depression. Davidson highlights evidence that exposure to marital stress is associated with a less persistent emotional response to positive stimuli.

### ***Psychological and Neurobiological***

Focusing on *Negative Emotionality/Neuroticism*, Shackman et al. offer the most detailed description of the psychological and neurobiological processes underlying an emotional trait. First, they highlight evidence that individuals with a more negative disposition tend to respond more strongly to aversive challenges and that this reflects trait-like variation in the activity and connectivity of a network of brain regions centered on the amygdala. Kagan and Davidson stake out broadly similar positions. Second, Shackman et al. make it clear that *Negative Emotionality/Neuroticism* is more than just hyper-reactivity, noting that individuals with a more negative disposition are prone to heightened negative affect in contexts where stressors are uncertain, temporally remote (i.e., occurred in the past or may occur in the future), or

psychologically diffuse (e.g., a novel experimental context). In fact, they review evidence that the vast majority of negative affect experienced in daily life is indiscriminate and cannot be attributed to clear-and-present challenges. They hypothesize that that this contextually inappropriate negative affect stems from alterations in the function of the central extended amygdala, an anatomical circuit encompassing the central nucleus of the amygdala and neighboring bed nucleus of the stria terminalis. They also highlight the possibility of that stress-induced sensitization of this circuitry contributes to the spill-over of negative affect across sequential contexts. Davidson outlines a broadly similar position, which he calls *Sensitivity to Context*, but focuses on work suggesting that contextually inappropriate negative reflects alteration in hippocampal function. Finally, Shackman et al. remind us that dispositionally negative individuals are often their own worst enemy and that they tend to behave in ways that increase the likelihood of stress, ultimately leading to more frequent, intense, or persistent negative affect. While acknowledging that the neurobiology of 'stress generation' remains ill understood, they speculate that differences in social appraisal processes mediated by the amygdala could contribute, at least in a distal way, to negative individuals' tendency to experience relationship insecurity, express less warmth and reciprocity, engage in avoidance, and evoke negative reactions from social partners.

Davidson was the only author to focus on the biological bases of *Positive Emotionality/Extraversion*. Building on other recent work (Berridge & Kringelbach, 2015; Greer, Trujillo, Glover, & Knutson, 2014; Kringelbach & Berridge, 2012; Wu, Samanez-Larkin, Katovich, & Knutson, 2014), he highlights new evidence that individuals marked by longer-lasting striatal activity in the scanner environment tend to experience more persistent positive affect in their daily lives, as indexed using ecological momentary assessment techniques.

## Moving Beyond Conventional Emotional Traits

Shiner and Kagan emphasize that we will need to move beyond conventional traits if we are to fully understand lasting individual differences in mood and emotion. Shiner emphasizes the role of personal narratives, the stories that individuals tell to themselves and others as a way of making sense of their identities. Kagan tells us that people often identify with their demographic group (e.g., social class, race) or with other individuals (e.g., parents, grandparents) in ways that can promote recurrent feelings of pride, shame, guilt, or anger.

## Conclusions

In the first edition of this volume, Ekman and Davidson challenged several leading theorists (Jeffrey Gray, Richard Lazarus, Mary Rothbart, and Davidson himself) to address the nature and origins of individual differences in emotion. Their responses, which drew on what was, at the time, cutting-edge research (e.g., gross surgical lesions in rodents, low-density electroencephalography recordings in humans), highlight the tremendous advances that have been made in the past two decades, especially as concerns the biological bases of emotional traits. Rothbart's prescient essay, which focused on the broad dimensions of *Positive Emotionality*, *Negative Emotionality*, and *Effortful Control*, reminds us that powerful new tools are not, in themselves, sufficient, to rewrite theory. Nevertheless, existing theories of emotional traits are mostly superficial and descriptive (Epstein, 1994; Funder, 1994). Developing a deep understanding of emotional traits will require a greater integration of work in humans and animal models, a greater emphasis on mechanistic approaches (e.g., neurofeedback, pharmacological interventions), and a willingness to develop and refine new traits based on observable differences in brain structure and function (A. S. Fox & Shackman, *in press*; Shackman & Fox, 2016; Shackman, Tromp, et al., 2016). Doing so promises crucial new opportunities for constructive intervention.

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