Commentary

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Stimulus and Response: Advancing Theoretical Rigor in Early Adversity Research

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Adverse childhood experiences have potent and enduring influences on children's development. Advances in our understanding of these impacts require improvements to the characterization of both the stimulus (adverse experiences) and the response (emotional processing) in a developmentally informed way. In Saarinen *et al.*'s (1) rigorous and informative meta-analysis in the current issue of *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, they investigated the strength, consistency, and moderators of the associations between childhood adversity and 1) the speed and accuracy of the recognition of facial emotions and 2) amygdala activation to emotional faces. However, the questions that remain unanswered by this study underscore the need for greater consistency and theoretical rigor in the characterization of both adverse stimuli and emotional responses in early adversity research.

Stimulus: Characterizing Adverse Experiences. Several approaches have been taken to characterize early adversity. One approach focuses on a single type of adverse experience (e.g., physical abuse or institutional rearing). However, different types of adverse experiences frequently co-occur, and exposure to multiple co-occurring adversities likely results in more severe outcomes than a single adverse experience. Recognition of the high co-occurrence of adversity led to the approach of using aggregate measures, often termed cumulative risk or adverse childhood experience scores (2). This approach implicitly assumes that all adverse experiences influence development through the same underlying mechanisms and with a similar magnitude (2). Saarinen *et al.* (1) operationalize adversity broadly to include studies of abuse, neglect, institutionalization, traumatic events, and pediatric illness, reflecting a conceptualization of adversity in line with these assumptions.

Dimensional models propose that complex environmental experiences can be distilled into multiple distinct, underlying dimensions of adversity (3). Two initial dimensions proposed are deprivation (the absence of environmental inputs that the brain has evolved to expect during development) and threat (experiences involving harm or the threat of harm). Other dimensions, including unpredictability in the environment, have also been proposed to influence development in distinct ways. Experiences of threat are thought to be associated with heightened behavioral and neural sensitivity to potential threat cues, while environments characterized by deprivation are associated with differences in the development of the brain's language and cognitive control circuitry (3). Indeed, in our systematic review of the literature on childhood adversity and neural structure and function, my colleagues and I found evidence supporting distinct associations of threat and deprivation with structure and function of the frontoamygdala and the cognitive control network, respectively (4). However, this question has not yet been subjected to the rigors of meta-analysis. In future work, greater standardization in measures of adversity, and theory-driven evaluations of dimensional versus cumulative risk models in both individual studies and meta-analyses will allow us to empirically evaluate these models.

Response: Characterizing Emotion Processing After Early Adversity. Implicit in the prevailing models of the neurodevelopmental consequences of adversity is an assumption that these experiences have universally negative consequences, leading to higher rates of mental and physical health problems among children who experience adversity. However, this deficit-based approach has been criticized for stigmatizing individuals who are exposed to adversity and ignoring their strengths (5). The assumption that all neurobiological or behavioral variations resulting from adverse experiences reflect dysfunction may impede the development of a more accurate and theory-driven mechanistic understanding. An alternative conceptualization, the hidden talents model, suggests that behavioral and neural responses to experiencing adversity can be conceptualized as adaptations that in many cases promote success in harsh or unpredictable contexts, but these adaptations may have trade-offs that manifest in greater difficulty in more normative environments (5). Alterations to facial emotion processing may reflect both adaptations and trade-offs. As Saarinen *et al.* (1) suggest, individuals exposed to violence may adapt to detect conflict and threat, as indicated by angry expressions, more quickly. Indeed, their meta-analysis found that youth exposed to adversity were able to accurately label angry faces with faster reaction times. However, this enhanced threat detection may come with the trade-off of less fine-grained differentiation of negative emotions, because exposure to early adversity was also associated with lower recognition accuracy of happy and fearful (but not sad or angry) faces.

Saarinen *et al.* (1) have advanced the characterization of emotional responses to early adversity by breaking down findings on the association between adversity and amygdala reactivity by the emotion expressed by the face. They found that early adversity was associated with greater amygdala reactivity to sad faces, but not to angry, fearful, or happy faces. A previous meta-analysis based on many of the same studies

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found that amygdala activity in response to emotional faces in general was more likely to be elevated in participants who had experienced childhood maltreatment (6). Amygdala responses have not been found to differ in a consistent way to specific emotions (e.g., anger vs. happiness) (7), and labeling emotions leads to lower amygdala responses than passive viewing (8). This suggests that while the amygdala does not differentiate strongly between emotions, the act of recognizing and applying labels to emotions supports emotion regulation.

Lower facility in labeling happiness and fear and greater amygdala reactivity to sadness among individuals who experience early adversity may reflect greater difficulty in labeling and regulating emotions that generally do not convey the presence of threat, a potential trade-off of enhanced threat detection. However, this interpretation also suggests a challenge to conducting a meta-analysis across these different functional magnetic resonance imaging studies; the specific contrasts used in studies within the meta-analysis determine the effect sizes and interpretation of findings. In the studies included in the Saarinen *et al.* (1) meta-analysis, the stimuli that are contrasted with emotional faces include neutral faces, shapes, and the baseline fixation cross. These discrepancies make it difficult to identify consistent patterns. Neutral faces, while providing a more stringent visual control, are ambiguous. The amygdala responds to uncertainty (9), and it is plausible that individuals growing up in harsher or more unpredictable environments may be particularly sensitive to uncertainty about the emotion that a face is expressing. Indeed, as Saarinen *et al.* (1) suggest, individuals exposed to early adversity may be more likely to perceive neutral faces as threatening. Therefore, the nature of the adaptations or trade-offs suggested by differences in amygdala activation to emotional faces is largely dependent on what activation to those faces is compared against. Saarinen *et al.* (1) have therefore advanced the characterization of emotional responses to early adversity but also highlighted several questions for the field to continue to explore.

Development. There may be specific developmental periods in which the brain is particularly sensitive to the presence or absence of certain stimuli, and the behavioral or neurobiological sequalae of adversity may manifest differently at different points in development. Therefore, understanding the consequences of adversity requires a developmental lens. Saarinen *et al.* (1) found that the associations of adversity with happy and fearful face recognition were moderated by both the timing and age of exposure. Lower recognition accuracy was specific to 3- to 5-year-olds who had been exposed to adversity before 3 years of age, reflecting developmental specificity of both the stimulus and the response. In the studies included in this meta-analysis, adversity occurring before 3 years of age likely reflects deprivation of both cognitive stimulation and social inputs during a sensitive period for the development of language and caregiver attachment. However, these differences are only observable in the 2 years after this experience, likely because accurately labeling basic emotions like happiness and fear approaches a ceiling by around 7 years of age, regardless of adversity experiences (10). After this age, differences in emotion processing and knowledge are likely to manifest in more complex or implicit ways, including amygdala reactivity.

In conclusion, Saarinen *et al.* (1) demonstrate what studies on emotion processing in individuals exposed to adversity can collectively tell us: 1) children exposed to adversity have more difficulty labeling happiness and fear accurately but are able to label sadness and anger more quickly, and 2) individuals exposed to adversity have heightened amygdala reactivity to sadness but not to other emotions. Further, the results of this meta-analysis suggest the importance of developmental timing in both exposure to adversity and the nature of emotional responses. However, this study also reveals how inconsistency and a lack of specificity in the characterization of both the stimulus (childhood adversity) and the response (particularly amygdala reactivity) have limited the ability to draw clear conclusions. Rigorous, theory-driven tests comparing dimensional and cumulative risk approaches to characterizing adversity across development in relation to specific outcomes will improve our understanding of the stimulus. Eschewing deficit assumptions in favor of conceptualizing outcomes in terms of adaptations and trade-offs in specific, clearly operationalized emotion processes will advance our understanding of emotional responses to childhood adversity. As Saarinen *et al.* (1) demonstrate, considerable knowledge has been gained in the last 2 decades of early adversity research. Over the same time period, the theoretical characterizations of both adverse stimuli and emotional responses have also advanced. Future empirical work must reflect these theoretical advances for early adversity research to progress to the point where it can effectively inform policies and practices that will improve the lives of children who face adversity.

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Article Information

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