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The Role of Physiological Response in Understanding Resilience Processes in Children's Development

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Introduction

Stress and adversity affect children in different ways. Some children develop behavioral or emotional challenges when exposed to difficult environments, while others overcome challenges and thrive. For decades, researchers have studied this variability in children's developmental outcomes to try to identify individual, family, school, and community processes that help some children to show "resilience" — that is, positive adaptation in the face of adversity.[1] By investigating physiological sensitivity and responses to adversity, researchers can gain more holistic understanding of how the interplay of biological and behavioral adaptations support or undermine children's resilience processes across different contexts.[2-4] Despite focusing on individual differences in adaptations and experiences, developmental psychologists recognize that children's capacity to respond to adversity depends largely on their access to contextual resources and supports as well as systemic processes and social policies.[5-7]

Research Context

When children are exposed to various types of challenges and stressors — ranging from everyday difficulties to pervasive and chronic adversity— their bodies respond. Physiological responses are a set of highly integrated changes including those related to heart rate, breathing, and stress hormones. By studying differences in children's physiological response, researchers are revealing the dynamic interplay between contextual adversity, biology, and behavioural adaptation. Individual differences in children's physiological responses are complex and dynamic because they can be shaped by early experience, can change over time, and differ depending on the type of challenge. Physiological response can be measured as a relatively brief reaction to an acute stressor (i.e., "reactivity"), or more prolonged response that reflects cumulative responses or adjustments over time. Further, the effect of children's physiological responses on their emotional and behavioral adaptation can vary across different contexts.

Current research has focused on two systems of the body that are activated when children face challenging or stressful situations. The first system is fast-acting, known as the "fight or flight response", and can also help the body recover from a state of arousal and regulate it back to homeostasis. The second system is slow-acting and prepares the body for chronic exposure to stress by suppressing systems that do not promote immediate coping and increasing available energy to manage stress.[8] These systems' responses can be measured using various non-invasive measures such as cardiac readings (e.g., electrocardiogram) or hormone levels (e.g., cortisol) collected from saliva[9] or hair samples.[10]

Key Research Questions

Researchers studying how physiological response is associated with resilience are tackling these key questions:

1. How do children's early adverse experiences relate to their physiological response, and can supportive interventions help?
2. How do children's physiological response and the environment interact dynamically to explain differences in adaptation and resilience?
3. What skills and experiences can help children regulate their physiological arousal and promote positive adaptation?

Recent Research Results and Gaps

Physiological response as an index of adversity exposure and intervention effectiveness

Children's experiences of adversity may play a role in shaping their physiological stress responses over time.[11] Studies have shown that children's exposure to adversity is associated with dysregulated physiological stress response that is either too high or too low.[12,13] For example, children who grow up with parents who are less sensitive or are abusive often display heightened physiological reactivity to acute stressors.[12,13] Early experiences of fear may sensitize children's systems to react more readily to future threatening situations by heightening their stress response.[14–17] This heightened physiological reactivity may be protective in situations of immediate threat, but over time, is associated with increased susceptibility to psychopathology such as depression or anxiety.[18,19] This association provides evidence of the "biological embedding of adversity" a hypothesis which states that early exposure to negative environments affects the children's central nervous system, and over time may adversely impact their cognitive, social, and behavioural development.[20]

To capture the wear-and-tear of various physiological stress response systems in the context of chronic adversity, researchers have employed a cumulative index of allostatic load.[21] Allostatic load is a way of measuring multiple types of heightened physiological stress response and inflammation (e.g., including heart rate, blood pressure and cortisol levels and immune and metabolic markers) that are linked to poor health outcomes in adulthood.[22,23] Children who experience greater adversity early in life consistently show greater allostatic load which in turn is linked to a broad range of negative outcomes later in life.[24,25] Even youth who are raised in poverty but appear to be well-adapted in their emotions and social behavior show high levels of allostatic load.[26] This finding suggests that resilience can be "skin deep"; physiological markers can reveal the toll adversity takes on the body even when children appear to be thriving.[26] Other ways of measuring wear-and-tear on the body include oxidative stress and metabolic markers, which are also elevated among children who face high levels of adversity.[27–29]

The processes through which adversity "gets under the skin" depend on the intensity, timing, and length of stress and adversity exposure.[20] Thinking about the timing and type of measurement is crucial. Recently, researchers proposed two distinct pathways to further elucidate how adversity can become biologically embedded.[16] This "dimensional model" distinguishes between children's experiences of active threat in their environment versus deprivation or lack of access to crucial

resources or supports.[16] Other researchers point out that many stressful childhood environments involve both threat and deprivation; these two dimensions are often inextricable and shape stress response systems together.[25] Further, they highlight that measurement should capture children's subjective perceptions of adversity, as not all children may experience a given stressor the same way.[25] Future research that attends to these measurement issues can advance knowledge of children's physiological response and adaptation to adversity.

Physiological markers may also be useful for indicating treatment effectiveness in ways that have relevance for child policy and practice. For example, infants of women who received a mindfulness-based intervention during pregnancy showed more self-regulated behavior and more efficient physiological response and recovery from a stressor.[30] In another study, foster care children who received a therapeutic intervention did not show expected dysregulated cortisol rhythms when they changed placements, compared to their foster peers who did not receive the interventions.[31] These studies suggest that early supportive intervention may reduce physiological risks associated with residential and caregiving instability.[32,33] At the same time, a recent systematic review found that the results of different studies were mixed and depended on the specific physiological stress response system.[33] This finding highlights a need to better understand how to design and target interventions to mitigate the negative impacts of adversity on child physiology and wellbeing. In addition, more research could explore whether children's physiological stress responses explain why certain interventions work for some children but not for others and elucidate how to better design and target services.

Physiological response as a marker of susceptibility to environmental influences

Indices of physiological reactivity to stressful experiences has been conceptualized as a marker of susceptibility to contextual influences. Applying evolutionary principles, researchers theorize that children who show heightened physiological or behavioural reactivity are more sensitive to both positive and negative environments than their peers who exhibit lower reactivity, that is, "for better and for worse".[34,35] High physiological reactivity may be maladaptive in contexts of adversity, but healthy and promotive in contexts of nurturance and protection. For example, children with high levels of physiological reactivity displayed more behavioral challenges when raised in families with high levels of adversity (e.g., conflict, stress, low income), but more positive behavioral adaptation in families with relatively low adversity.[36,37] Framed another way, children with low reactivity showed better adjustment in contexts of adversity.
While many studies have demonstrated the association between low reactivity and better

adjustment in contexts of adversity,[36,37] in some cases, low reactivity could be protective. For example, there is evidence that high physiological response may be protective for children who are exposed to interpersonal conflict.[38] In addition, relatively higher levels of physiological response over time may be protective in circumstances of extreme poverty where stress response systems can become blunted.[39] The adaptive calibration model[2] distinguishes between two profiles of maladjustment in contexts of high adversity: low stress responsivity that is related to callous-unemotional traits (e.g., lack of empathy), and higher stress responsivity that is associated with more anxious patterns of emotion and behavior. This work highlights the plasticity of children's physiological response and the importance of disentangling in which specific conditions high or low response has a buffering effect against adversity.[11]

Given that most research on children's stress physiology has come from the United States context, more research is needed in low- and middle-income countries to provide greater representation of children's experiences worldwide. Further, research from low- and middle-income countries can help us to understand how children's stress physiology interacts with other biological processes including access to nutrition, and pathways of infection and inflammation that may activate or interplay with stress response systems. This research will be strengthened if we also include measures of positive environmental influences and children's adaptive functioning, recognizing the strengths of diverse families from under-resourced communities. Positive and enriching experiences may promote physiological regulation and holistic wellbeing, over and above mitigating the negative effects of adversity.

Skills and experiences that may help children regulate their physiological arousal and promote more optimal responses

Researchers are examining how children's physiology response changes as they encounter, engage with, and recover from contextual challenges. This research increasingly models physiology as a dynamic process that changes over time.[40] By examining the entire trajectory of children's reactivity and subsequent recovery, researchers aim to identify patterns of physiological response that help children to thrive in the face of adversity. Although exposure to high levels of adversity may predispose many children to develop highly sensitive physiological profiles, resilient children may also develop self-regulatory skills that produce fast and efficient recovery from that arousal. For example, children with greater self-regulatory skills showed moderate levels of physiological reactivity during laboratory challenges and recovered more quickly.[41,42,43]

Related constructs such as children's executive functioning, coping and coregulation with parents are also important predictors of how children react to and recover from challenges. For example, parents' levels of hair cortisol were not correlated with their children's hair cortisol levels among children with better emotion regulation, suggesting that emotion regulation skills may mitigate transgenerational effects of ongoing physiological stress.[44] Examining how different aspects of physiological response and self-regulation work together will help illuminate processes that promote children's resilience.[6]

The field of applied developmental psychobiology is starting to consider how to leverage research about children's physiology in ways that support their wellbeing. Physiological research may elucidate how unequal educational experiences of children from historically marginalized groups affect their developmental outcomes.[6] In one study, attending child care was associated with a suboptimal, flat cortisol response for Spanish-speaking Latine children, but having a Spanish-speaking teacher seemed to create a more supportive classroom environment that was linked to healthier cortisol response. More studies are needed to identify specific system level changes, practices and protective factors that reduce stress for children who face inequalities in treatment or access to resources.[7] Such work will help to illuminate processes that promote equity.

In addition, low-cost, scalable interventions that teach children skills for coping and self-regulating may be helpful.[45] For instance, a field experiment taught 5 to 12 year old children deep breathing skills via a short video and found that it significantly decreased their physiological activation and calmed the nervous system.[46] Children's appraisal of stressors (i.e., perceptions and beliefs) may also play a significant role in how they physiologically respond and recover.[47]

Conclusion and Implications

Resilience researchers have made significant advances in linking children's physiological reactivity to both adversity exposure and their behavioral functioning. This work has highlighted the importance of examining how the biological embedding of adversity affects children, and how the environment and children's physiological responses interact dynamically to predict development of the life course. By examining the contemporaneous association between physiological reactivity and self-regulatory skills, we may be better able to understand the resilience process for children who exhibit high physiological reactivity. Importantly, we must always remember that resilience is a dynamic process, meaning that it is malleable and changes over time.

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