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Nontoxic Family Stress: Potential Benefits and Underlying Biology

Special Issue Guest Editor's Note: *In this article the authors discuss potential benefits of normative exposure to stress in children's daily lives, emphasizing development of emotion regulation and coping and functioning of the neuroendocrine and immune systems. In the paired article, "Work–Family Conflict and Health Among Working Parents: Potential Linkages for Family Science and Social Neuroscience" (this issue, pp. 176–190), Grzywacz and Smith examine the stress-based, biobehavioral framework underlying paid work, parenting, and health research and then summarize selected areas of social neuroscience research with a focus on stress and health research as having the potential to further our understanding of how different work–family experiences should be conceived as "stressors" and, if so, how they may get "under the skin" to affect health outcomes.*

Abstract

Exposure to family stressors that are an ordinary part of daily life is essential for healthy development. Most children show a "positive" response when stressful events provoke mild or moderately intense levels of emotional arousal and provide opportunities for recovery. Through processes of habituation and practice, responding to these types of stressors can foster the development of emotion regulation and coping under normative levels of exposure. Parents influence children's opportunities to experience self-regulation and their psychological responses to stress and thereby shape their preparation to respond to stressors in the future. Different levels of stress exposure are also associated with different patterns of resting activity and responses to stress in the neuroendocrine and immune systems. When incorporated with information on exposures, protective factors, and outcomes, those biological responses can help us understand how resistance to future stressors is increased through exposure to nontoxic levels of family stress.

Repeated exposure to chronic stressors like family violence can be detrimental to the mental and physical health of children (Repetti, Taylor, & Seeman, 2002). But these models can be taken too far when extended down in a linear fashion to normative levels of stress exposure. Mild and moderate levels of stress do not necessarily have the same effects on health and development as do high levels of chronic stress, only at a lower level of magnitude. Figure 1 depicts a theoretical inverted *U*-shaped curve that may better approximate the effects of stress on child development. The *x* axis depicts levels of exposure, ranging from "very low" to "very high," that reflect a combination of the intensity, frequency, and duration of multiple stressors. Increasing exposure is associated with a decline in functioning only on the right side of the figure, after crossing

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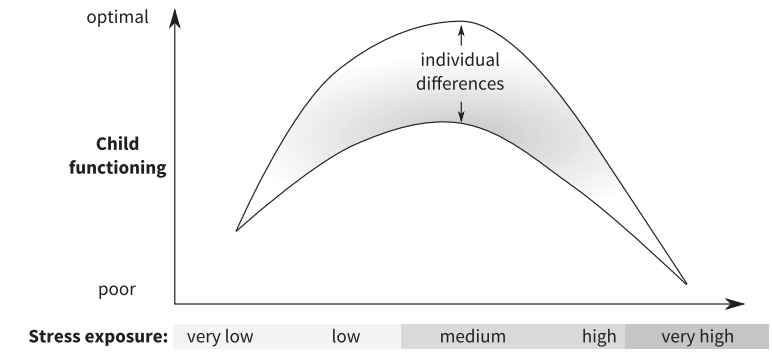
FIGURE 1. INVERTED-*U* FUNCTION DEPICTING CHILD FUNCTIONING AT DIFFERENT LEVELS OF STRESS EXPOSURE.



the midpoint. Most children experience stressors that fall within the broad center of the continuum, where there is a much flatter association with health and development. Although children are potentially exposed to many sources of stress both inside and outside of the home, which can have additive and multiplicative effects, in this article we focus primarily on family stressors. Our goals are to outline potential benefits of exposures to levels of family stress that are in the low to medium range, as well as to review the major biological stress-response systems and the possibilities of showing tolerable responses to high levels of stress.

In this article we discuss two, partially overlapping, levels of stress exposure that we have labeled *normative* and *moderate*. In our use of the term, a *normative* level of stress spreads across the low-to-medium range of the *x* axis in Figure 1. It encompasses daily experiences with common family interactions and events that generate brief, mild expressions of negative affect (e.g., parent–child conflict, family demands, parental disappointment and associated feelings of irritability, frustration, disappointment, and sadness) and occasional events that are more stressful but not outside the ordinary realm of life (e.g., witnessing arguments between parents). We define *moderate* levels of stress exposure as spanning the medium-to-high sections of the *x* axis. This is also a very wide range; it includes chronically stressful conditions, such as growing up in neighborhoods with high crime rates, and stressful events, such as parental arguments that recur on a frequent basis, as well as events that are not normative, such as parental divorce. Moderate levels of stress exposure can be associated with poor developmental and health outcomes; our analysis highlights the role of protective factors in these settings.

We are concerned with the effects that normative and moderate levels of stress have on the developing child's biological and psychological stress response systems. As we will discuss, normative stressors typically elicit what some have called a "positive" stress response; moderate stressors usually generate more intense emotional and physiological reactions but, under certain supportive conditions, can elicit a "tolerable" stress response (National Scientific Council on the Developing Child, 2005/2014). The positive and tolerable responses contrast with "toxic" responses usually observed in the context of significant and chronic stressful conditions and traumatizing events like family violence, childhood neglect, and exposure to war. Our article does not address those significant adversities, which define the "very high" end of the *x* axis in Figure 1 and are the focus of most research on childhood stress. Neither does it delve into research on resilience, the reduced vulnerability shown by individuals who function better than most others in similar high-risk situations (Luthar, Cicchetti, & Becker, 2000; Rutter, 2012).

Levels of daily stress at the "very low" end of the continuum may exist only as a theoretical possibility, as the challenges of real life inevitably intrude, but it may represent a goal to which some well-meaning parents aim. Though not typically addressed in the stress literature, efforts to shield children from normative levels of stress could foster problems such as increased sensitivity and reactivity to events and poor

coping skills. In other words, the ideal family environment is not akin to a cloister; trying to restrict children's exposure to stressors that are a regular aspect of life—disappointments, frustrations, failures—may be a disservice to them. For example, maternal separation is a normative daily stressor with which infants must learn to cope. In recent investigations in Australia, rates of secure attachment among infants were highest when mothers returned to work within the first 5 months of birth and lowest when mothers did not return to work by the end of the first year (Harrison & Ungerer, 2002).

Our article is largely based on the "risky families" model of the effects of high and very high levels of chronic family stressors. It is a framework that integrates research on children's social, emotional, and biological development to explain how early family social environments can "get under the skin" and shape long-term mental and physical health outcomes in adolescence and adulthood (Repetti et al., 2002). The same mediating factors are used in this article to understand social, emotional, and biological development under conditions of normative and moderate levels of stress. We begin by discussing two areas of child development that benefit from exposure to some daily stress in the family: emotion regulation and coping. We then review biological stress response systems, patterns of biological responses that may be associated with moderate levels of stress, and issues with making inferences about stress exposures based on biological response patterns. We conclude the article with suggestions for moving toward a better integration of psychological and biological perspectives on stress.

Psychological Processes Linking Normative Family Stress to Healthy Child Development

The verb *to steel* is used to connote strengthening or hardening. In the context of stress research, the term *steeling* refers to an increase in resistance to future stressors that results from exposure. According to the analysis we present next, that resistance may be due to the development of more effective emotion regulation, problem solving, and other types of coping that are associated with normative exposure to stressful events.

Emotion Regulation and Coping

Common family stressors, like interpersonal conflict or expressions of disapproval, generate negative internal responses such as anger, sadness, anxiety, disappointment, and a loss of self-esteem. Imagine children's subjective experiences in the face of stressful family events like witnessing parents arguing, or a parent's expression of disappointment in the child's behavior, or social exclusion by a sibling. Practice managing emotional responses to social experiences like these promotes effective emotion-regulation strategies. DiCorcia and Tronick (2011) used the analogy of training for a marathon: A runner's endurance results from the conditioning that is achieved by accumulating many miles of practice runs. That type of preparation can be compared to the capacity that builds as children not only experience negative emotions in the family environment but also experience recovery from those distressing states.

Habituation may be an important component of emotion regulation that results from the "practice runs" of negative emotional experiences. *Habituation* is the phenomenon by which physiological and emotional responses to a stimulus decline with repeated exposures, and it is crucial to the mechanism by which exposure therapies work. Indeed, the most effective intervention for anxiety disorders is repeated exposure to the anxiety-provoking situations, and exposure as a means of change underlies effective treatments for many other emotional problems. The unified protocol for the psychological treatment of all disorders that have at their core the experience of negative affect, including symptoms of depression and anxiety, focuses on changing the way that clients regulate emotion. One of the essential therapeutic ingredients is provoking exposure to, and expression of, the negative emotion in order to improve emotion regulation (Barlow, Allen, & Choate, 2004). Similar methods are central to "acceptance and commitment" therapies and mindfulness interventions (Hayes, Strosahl, & Wilson, 1999). Just as exposure to distressing emotions under appropriate clinical conditions can be therapeutic, in the context of a safe and supportive family setting exposure to negative emotions may familiarize children with negative states and thereby reduce the threat they pose and facilitate management of distress.

In addition to habituation through exposure, experiences with recovery from daily stressors may also carry emotional benefits. DiCorcia and

Tronick (2011) noted that a crying infant's transformation from a distressed state to a calmer state can be accompanied by cascades of positive affect, at least under some circumstances. Older children may similarly experience a positive affective response and sense of mastery following comparable kinds of reparatory successes. Consider a four-year-old boy who becomes very angry and upset during a fight with a sibling, so much so that his emotion-regulation capacities are overwhelmed and he begins to cry. The relief that the child experiences upon recovering from that distress, particularly if it is accompanied by comfort from the sibling or another family member, illustrates how a positive affective state may result from a reparatory success. The same phenomenon can be observed in a nine-year-old girl who returns home after a day during which she had social problems with other children at school. The emotional relief associated with returning home to a loving and caring family may provide a boost to the child's self-esteem and put the difficult interactions at school in a new perspective. Whatever the particular mechanism, emotion regulation may be enhanced by experiencing dynamics that include sequences of stress → recovery → positive emotion (DiCorcia & Tronick, 2011).

Most models of the effects of chronic high levels of stress, such as the risky families model, posit that repeated exposure to stressors contribute to the accumulation of "hits" that exact a toll on psychological and biological systems (Repetti et al., 2002). Not only does recovery interfere with processes of accumulation, but we also are noting possible additional benefits, including the facilitation of habituation processes and, under some circumstances, even positive affective responses. In short, daily practice managing mild negative emotions, and occasional practice with more intense emotions that arise in most families, when combined with the possibility of recovery, provides a foundation for the development of emotion regulation. The corollary proposition is that only minimal exposure to stressors and the negative emotions they evoke limit the benefits that can be gained from habituation and experiences with recovery. The result could be increased sensitivity and reactivity to daily challenges that provoke negative emotion.

The increased regulatory capacity that results from repeated exposure to normative levels of stressors, and the experience of recovery from those events, may in turn facilitate more effective behavioral responses to those events. A naturalistic study of children's expressions of anger in the family found that the most prevalent causes were verbal disagreements with parents and siblings; other common contexts included requests for compliance, reprimands, homework, nonaggressive physical acts (e.g., a sibling blocking the child's view of the television), and refusals of the child's wishes (Sears, Repetti, Reynolds, & Sperling, 2014). The social skills needed to manage situations like these are more difficult to enact when in a highly aroused emotional state.

Moreover, like other kinds of skills, additional trials with social problem solving and other forms of coping should improve performance of those behaviors (Denham & Almeida, 1987; Webster-Stratton, Reid, & Hammond, 2001; Weisz, Thurber, Sweeney, Proffitt, & LeGagnoux, 1997). The practice that children get from coping with daily stressors at home provides them with opportunities to learn from both successful and unsuccessful strategies. Through trial and error, children learn how best to negotiate difficult social interactions with siblings and parents that involve sharing, managing responsibilities, negotiation of privileges, and differences of opinion, as well as others' demands and negative feedback. By working through these challenges children become proficient in social skills and coping strategies and learn to preemptively reduce the frequency, and control the intensity, of common stressful events. In most cases, the competencies that promote adaptation to their family environment will also serve children well outside of the home. For example, conflict-resolution strategies acquired at home can be applied in other social settings, such as during interactions with peers.

Characteristics of Stressful Events

We have argued that children's emotional and social development suffer when they are unduly shielded from experiencing stressors and that there are emotional, cognitive, and behavioral advantages to be reaped from exposure to normative amounts of family stress. Of course, at some point the curve in Figure 1 eventually bends downward. The change in direction shows the limits to the developmental benefits when children are exposed to high levels of chronic stress or negative emotional arousal. Moreover, not all stressful experiences, even at moderate

levels of frequency and intensity, offer opportunities for growth. A child's age is fundamental to understanding responses to stressors because, as children develop, the type and the amount of daily stress that promote a positive response change. For instance, as infants advance from parents serving as external regulators of stress to self-regulation, they are able to manage higher levels of challenge and demand (DiCorcia & Tronick, 2011).

The probability of a positive response to a stressor is also determined by the characteristics of the event itself (Davies & Martin, 2014; Skinner, Edge, Altman, & Sherwood, 2003). Because the experience of recovery from negative emotional arousal facilitates habituation, stressful events that provide adequate opportunity for a return to baseline levels of arousal should promote the development of emotion regulation. We argue that, like physiological recovery processes, emotional recovery is more likely to occur in the context of events that provoke reactions that are mild to moderate in intensity and when stressors occur at a frequency and over a time course that leaves time for restoration to take place (Marquez, Belda, & Armario, 2002; McEwen, 2000). In fact, the most common stressful events in families fit this description, precipitating mild feelings of annoyance or disappointment. In the naturalistic observational study mentioned earlier, the majority of negative emotions that children expressed at home were of low intensity and brief duration (Sears et al., 2014). Of course, some family stressors present greater challenges to emotional recovery, particularly when they arouse more intense negative affect or occur in closely spaced repeated sequences. For example, forms of conflict between parents that contain cues of interpersonal threat, such as angry expressions and loud voices, are particularly distressing to children (Davies & Martin, 2014). Witnessing family arguments that persist over a prolonged period without resolution may similarly interfere with restorative processes. Descriptions of "toughening" of stress-response systems in the context of repeated physical challenges have also emphasized the necessity of recovery intervals (Dienstbier, 1992).

Family stressors that offer options for successful coping and a sense of mastery and efficacy provide good opportunities for socialization. Most normative family stressors would fall into the category of controllable events, such as arguments with siblings or parental demands. Stressors that are controllable tend to trigger problem-solving responses (e.g., instrumental action, strategizing, etc.; Skinner et al., 2003), and problem-focused coping in response to controllable stressors is associated with better psychological functioning (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001). Moreover, these kinds of responses promote higher *coping efficacy*, the belief that one has dealt well with stressors in the past and can deal effectively with future stressors, which in turn helps maintain lower levels of internalizing problems; the opposite appears to be the case for avoidance coping (Sandler, Tein, Mehta, Wolchik, & Ayers, 2000). In contrast, adjusting to stressful uncontrollable situations, such as conflict between parents, depletes inner resources for self-control (Muraven & Baumeister, 2000).

The Role of Parents

Parents play a very important role in how children respond, both emotionally and behaviorally, to common daily stressors. Parent responses communicate how negative emotions should be managed (Lunkenheimer, Shields, & Cortina, 2007). The development of self-regulation is fostered by parental responsiveness, warmth, and emotional support and by minimal interference with and intrusion into the child's autonomous activities; harsh forms of parental control lead to increased negative emotional reactivity (Bates & Pettit, 2014; Eisenberg, Smith, Sadovsky, & Spinrad, 2004). Parents of older children and adolescents also provide socialization by making coping suggestions; in particular, by encouraging purposeful engagement in problems, parents convey confidence in their children and foster feelings of agency and efficacy (Abaied & Rudolph, 2011). Of course, other members of the household, such as siblings, extended family members, and other caregivers, also help shape how a child responds to stress. Children growing up in conflictual and non-nurturing family environments use less effective coping strategies, such as tension reduction, distraction, and escape in stressful situations (Repetti et al., 2002).

According to the *everyday stress resilience hypothesis*, parents of infants provide scaffolding and function as external regulators for them, thus permitting the infant to experience what

DiCorcia and Tronick (2011) call "reparatory success." At moments when there is a mismatch between the infant's needs and the regulatory input provided by parents, "reparatory failures" occur which function as "microstressors" for infants. This model suggests that parents should aim for appropriate levels of capacity-increasing stress. Waiting too long to intervene in response to an infant's needs may mean that the infant has become inconsolable. On the other hand, intervening too soon may mean that the infant misses a chance to experience microstressors and, therefore, opportunities to self-regulate (DiCorcia & Tronick, 2011). In the long run, infants reared by hypervigilant and intrusive parents pay a cost with respect to emotional development and self-regulation.

The same model of emotion reparation as a dyadic process can be extended to older children. As parents continue to influence the development of emotion regulation and coping in children beyond the infant years, they need to fine-tune their involvement and responsiveness to their children's emotional needs. Parental neglect itself functions as a debilitating chronic stressor in children's lives (Repetti et al., 2002). This article addresses the disadvantages of parental overinvolvement and the benefits of limited parental involvement for the development of emotion regulation in children.

Too much parental involvement can impede child development. High levels of parent psychological control—behaviors that intrude into the child's self-expression and hinder individuation by attempts to regulate the child's emotions and behavior—are a negative and inhibiting experience for children that stifles independent expression and autonomy. Children reared by more psychologically controlling parents are more likely to show problem behaviors, particularly internalizing problems like depression (Barber, 1996). In one study, toddlers whose parents demonstrated high levels of intrusive control—restricting the child's independent activity and providing extra physical affection—were more likely to maintain their inhibited behaviors into the preschool years (Rubin, Burgess, & Hastings, 2002). These parenting styles limit children's experiences with self-regulation and their opportunities to practice coping strategies.

There is also evidence of the potential benefits associated with limiting parental responsiveness and involvement. According to Patterson's (1982) *coercion model*, negative child behaviors, such as whining, can be inadvertently reinforced by parental attention. Instead, the parent training literature suggests that parental ignoring discourages some types of negative child behaviors, such as protests (Pearl, 2009). Sperling and Repetti's (2015) naturalistic observational study of family life examined parent responses to spontaneous child expressions of mild negative affect and found that parent ignoring increased the likelihood that the child would switch to a neutral or positive expression within 30 seconds. Parent ignoring may provide children with opportunities to practice managing mild feelings of anger and sadness independently and thereby facilitate the development of emotion-regulation skills.

Individual Differences

There is great variability in how children react to daily stressors (Repetti, Robles, & Reynolds, 2011); in fact, the entire coping literature is based on this premise. For example, individual children respond with a variety of cognitive, emotional, behavioral, and physiological responses to conflict between parents and those response patterns correlate with their psychological adjustment; negative affective responses to disputes are a strong correlate of adjustment problems (Rhoades, 2008). According to *emotional security theory*, children who intervene in disputes between parents—for instance, by attempting to control the parents' emotionality and behavior before the conflict escalates—fare worse that children who do not try to get involved (Davies & Cummings, 1994).

Children who respond to common family stressors with low levels of reactivity, quick recovery, and good coping skills should experience the benefits of exposure to normative and moderate levels of family stress that we describe in this article. However, some will not fit the patterns described here. Children who respond to stressors with high levels of reactivity, slow recovery, and poor coping skills are less likely to benefit from habituation, recovery, and the development of effective problem-solving and coping skills. In a research sample that includes a mixture of children who respond in an adaptive manner and those who respond in a maladaptive manner to daily stressors, the net effect of exposure might look like zero. This type of suppression effect may explain why researchers

sometimes find no effects on child development associated with normative and moderate levels of stress exposure (Shrout & Bolger, 2002).

Biological Responses to Stress

Thus far, we have described how low to medium stress exposures may have benefits for cognitive, emotional, and behavioral responses to later stressors. In this section, we review the major biological systems that respond to stress and how exposure to moderate levels of stress should affect those systems. Biological responses to stress are not uniformly harmful to the individual; in fact, as we will describe, they are increasingly viewed as adaptive in the short term, despite their costs for health and well-being in the long term. In particular, biological stress responses that could be considered "positive" or "tolerable" may indicate an individual's ability to respond effectively to stressors in his or her environment (National Scientific Council on the Developing Child, 2005/2014), and appropriately protective family environments may nurture such responses (Bai & Repetti, 2015).

In the preceding section we focused on low to medium stress exposures in children; however, most research on biological responses to stress focuses on the medium to high range (see Figure 1). Moreover, few studies compare biological responses across the full range of stress exposures. Our primary focus is on physiological systems that branch out into the rest of the body (the periphery), where their effects have implications for physical health.

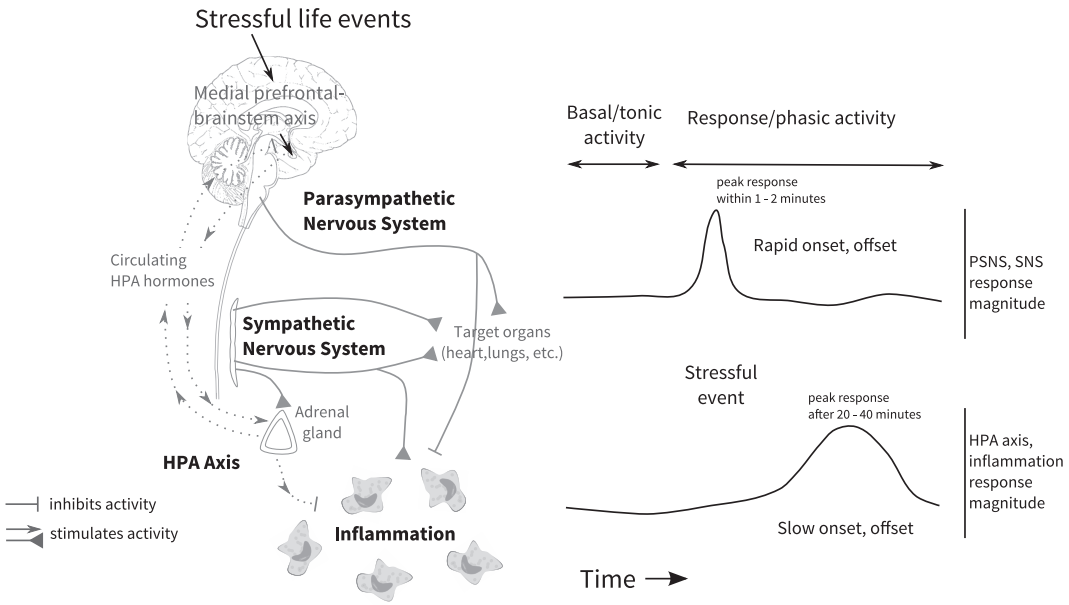
What Biological Systems Respond During Stressful Events?

Researchers who study the intersection between family environments and stress-responsive biological systems have primarily focused on the neuroendocrine system, in particular the autonomic nervous system (ANS) and the hypothalamic–pituitary–adrenal (HPA) axis, and the arm of the immune system that is responsible for inflammation (Miller, Chen, & Parker, 2011; Repetti et al., 2011). These systems, depicted in Figure 2, coordinate the body's response to environmental challenges and partially explain how the family environment can "get under the skin" and affect health. It is important to note that each system is governed by brain regions involved in processing social and emotional information that comprise a "medial prefrontal-brainstem axis" (reviewed by Grzywacz & Smith, 2016; also Lane & Wager, 2009). In that axis, evolutionarily newer brain structures (e.g., the prefrontal cortex, anterior cingulate) process information about the social environment and send signals to evolutionarily older brain structures (e.g., the amygdala, hypothalamus) that are more directly involved in sending signals to the rest of the periphery through the ANS, HPA axis, and immune system (see Figure 2). In other words, the neural circuits involved in emotion regulation and social information processing are also critically involved in modulating biological responses to stress.

Although the organs and tissues involved in sending signals, as well as the molecules that serve as signals themselves, vary widely among the ANS, HPA axis, and immune system, they share several conceptual similarities (see Figure 2). Because each system is critically involved in responding to environmental challenges like an immediately occurring stressful life event or infection, we can assess activity in each system during a *response to a challenge*, or *phasic reactivity.* The phasic response can be distinguished from activity in each system when challenges are not occurring, during a *basal state* or *tonic* activity (Repetti et al., 2011) that constitutes most of an individual's daily experience.

In addition to underlying biology, the ANS, HPA axis, and immune system differ from each other in two key ways (see right side of Figure 2). First, the amount of time it takes for a system to show a peak response (onset) and to return to baseline following the peak (offset) differs among the systems (Berntson, Quigley, & Lozano, 2007; Sapolsky, Romero, & Munck, 2000). The ANS has two branches: (a) the parasympathetic nervous system (PSNS) and (b) the sympathetic nervous system (SNS). PSNS activation slows heart rate and promotes growth and digestion, whereas SNS activation promotes the "fight-or-flight" response, speeding heart rate and increasing available energy for the brain and body's consumption. Of the systems described here, the PSNS has the fastest onset and offset, followed by the SNS, whereby peak responses occur within seconds to minutes upon exposure to challenge. The HPA axis, which is also involved in increasing available energy for brain and the body (among many

FIGURE 2. STRESS-RESPONSIVE BIOLOGICAL SYSTEMS AND THEIR ASSOCIATED TIME FRAMES OF RESPONSE.



other functions), is a slower system, with peak responses occurring tens of minutes after exposure to challenges. The inflammatory response, which is critically involved in immediately protecting the body during infection or injury, takes longer to show a peak response (30–45 minutes) after exposure to a noninfectious challenge, such as a brief stressor in the laboratory (Steptoe, Hamer, & Chida, 2007). A second key difference is that these systems vary in their ability to turn themselves off. ANS responses are not self-terminating; the medial-prefrontal axis is responsible for turning on and turning off the ANS. By contrast, a critical feature of the HPA axis is its ability to turn itself off, much like a thermostat turns off the heater when it detects that the room is getting too hot (Sapolsky et al., 2000). Similarly, the inflammatory response is also self-limiting, in that it stimulates other biological mechanisms that lead to turning itself off (Miller et al., 2011).

Stress Exposure and Peripheral Physiological Systems

We have described expected patterns based on prior theory and research, and in this section we primarily focus on rationale from the *adaptive calibration model* of stress (ACM; Del Giudice, Ellis, & Shirtcliff, 2011). The ACM recently emerged as a complement (Ellis & Del Giudice, 2014) to long-standing models of stress-responsive biological systems that focus on the long-term negative effects of toxic stress for mental and physical well-being, such as the *allostatic load model* (National Scientific Council on the Developing Child, 2005/2014; McEwen, 1998). Unlike toxic stress models, the ACM is an evolutionary framework that characterizes biological responses as the organism's "best" attempt to adapt to the immediate environment over the course of development. For example, in toxic stress models, an overresponsive SNS response to stressful events may be viewed as problematic, particularly for cardiovascular health decades later; however, the ACM posits that in the short term an overresponsive SNS may help a child effectively cope with immediate stressors, like witnessing a volatile argument between parents. Although there has been significant systematic study of the effects of high, toxic stress exposure on these systems in adults (Chida & Hamer, 2008; Miller, Chen, & Zhou, 2007), there has been less systematic investigation of inverted *U*-shaped patterns directly comparing events that elicit positive versus tolerable versus toxic responses, especially in children (cf. Ellis, Essex, & Boyce, 2005).

The ACM posits that moderate stress exposure is related to basal functioning that falls between levels for individuals exposed to low and very high levels of stress (see Table 1 of Del Giudice et al., 2011, p. 1578). One exception is basal HPA axis activity, which may look somewhat similar to individuals exposed to high-stress events. Indeed, although the picture is somewhat more nuanced, chronic, highly stressful events (particularly those of a social nature) are associated with elevated basal HPA activity such as higher daily or evening levels (Miller et al., 2007) and inflammation (Robles, Glaser, & Kiecolt-Glaser, 2005).

For phasic responses to stress, the ACM proposes that responses to stressful events can be adaptive depending on the environmental context (see Table 1 of Del Giudice et al., 2011). Children with exposure to moderate stress are expected to show moderate reactivity in the PSNS, compared to children exposed to very low stress (high reactivity) and very high stress (moderate to low reactivity; Del Giudice, Hinnant, Ellis, & El-Sheikh, 2012). For the SNS, exposure to moderate stress should be related to low to moderate reactivity, compared to higher reactivity for children exposed to low and high levels of stress (Del Giudice et al., 2012). For the HPA axis, which is a slower acting and self-limiting system, the ability to turn itself off may be affected by repeated exposures to stressful circumstances. Considerable evidence suggests that toxic stress responses lead to changes in the brain that ultimately impair the ability of the HPA axis to shut itself off (see Figure 2) and turn itself on (respond to stress; McEwen, 2007). Indeed, the ACM suggests that individuals exposed to moderate stressors may show a slower HPA axis onset in response to stress, and possibly no onset, as well as a slower offset, compared to individuals exposed to low or high levels of stress. For example, in a sample of adults reporting normal, nonclinical levels of anxiety and depressive symptoms, adults reporting greater distress showed a smaller cortisol response to stress compared to adults reporting lower levels of distress, and that a "blunted" pattern involving slow onset is similar to a pattern of responding observed in individuals with clinical depression (Brooks & Robles, 2009). Similarly, chronic stress impairs the ability of the inflammatory response to turn itself off, in part because of dysregulation of the HPA axis. Cortisol normally plays a major role in "dampening" down inflammation, and dysregulation in the HPA axis and how it interacts with the immune system can lead to less effective dampening (Miller et al., 2011; Robles et al., 2005).

Overall, current theory and some empirical data suggest specific patterns of physiological responses that accompany different levels of stress exposure. Thus, a tempting reverse inference is that the magnitude of a given biological stress response (e.g., average daily cortisol above a certain value) can be used to determine whether an individual has been exposed to low, moderate, or high levels of stress. In other words, stress-related biological measures could potentially substitute for traditional psychosocial measures of stress exposure.

Physiological Measures Are Not Sufficient for Making Conclusions About Stress Exposures

Measuring activity in the brain and peripheral physiology can shed light on mechanisms that explain how exposure to stressful life events can influence mental and physical well-being. That said, at this point peripheral physiological measures should not be viewed as indicators of the severity of stress exposure. The degree of stress severity (low vs. moderate vs. high), or any other psychological construct for that matter, cannot be inferred by the presence of particular physiological response patterns alone (Cacioppo & Tassinary, 1990), or by the presence of a particular response pattern observed in just one physiological response system. In addition, at this point in time peripheral physiological measures cannot be used to infer whether a child has derived benefit from stress exposures or is hardened against future exposures (e.g., low SNS reactivity as a marker of "hardening"). Ultimately, physiological measures are most informative when combined with information about the intensity of exposure, presence of protective factors, and, ultimately, the implications for mental and physical health outcomes. In the following sections we expand on these points using specific examples.

Exposures. The literature currently suggests that exposure to early life adversity is associated with a cortisol nonresponse to stressors in middle childhood (Repetti et al., 2011). Thus, one might be tempted to infer that children who show a nonresponse to stress are more likely to be

exposed to moderate to very high levels of stress. However, a study of cortisol reactivity to a social stressor in three different groups of children illustrated the problems with reverse inference (Gunnar, Frenn, Wewerka, & Van Ryzin, 2009). A moderate-stress group consisted of children adopted at an early age (before 8 months) from overseas institutional care. A high-stress group consisted of children adopted from overseas institutional care at a later age (after 12 months). Finally, non-adopted children raised by birth parents in the United States were the comparison, presumably normative, stress group. Children provided repeated salivary cortisol samples before, during, and after an acute laboratory stressor involving public speaking and arithmetic. The research group statistically identified discrete patterns of cortisol response to the stressor, including a nonresponse pattern involving a lack of cortisol response to the stressor. However, because cortisol nonresponders constituted the majority of children in the study (71% of the sample), the chances of a child being classified in the moderate-stress group if that child showed a cortisol nonresponse (43%) was roughly similar to the chances of being a member of the moderate stress group in the overall sample (35%). By contrast, the chances of having a cortisol nonresponse pattern if that child was exposed to moderate stress was quite high (85%) compared to exposure to high (69%) and normative stress (53%). Thus, a lack of cortisol reactivity, by itself, could not adequately distinguish whether someone was exposed to low, moderate, or high stress.

Protective Factors. Making inferences about stress exposures from physiological measures can also mask the presence of protective factors that might cultivate steeling. One protective factor that may help children cope with chronic stressors such as low socioeconomic status (SES) is developing "shift-and-persist" coping strategies, whereby *shifting* involves changing one's cognitive appraisals of stressful events (e.g., acceptance as a coping strategy) and *persisting* involves making meaning, seeing benefits, and even being optimistic in the face of adversity (Chen & Miller, 2012). In a sample of children with asthma, low SES was related to elevated asthma-related inflammation. At the same time, for low-SES children specifically, greater reports of using shift-and-persist strategies predicted lower asthma-related inflammation (Chen et al., 2011). In this example, reverse inferences about stress exposures based on inflammation alone (e.g., low inflammation implying high SES) obscured the presence of protective factors (low SES + high shift and persistent low inflammation) that could be identified only by actually assessing shift-and-persist strategies.

Outcomes. Ultimately, the case for the adaptiveness of a particular physiological response pattern requires measuring longitudinal outcomes. For example, as described earlier, exposure to moderate stress was uniquely associated with a lack of a cortisol response to stress (Gunnar et al., 2009), consistent with other studies on adverse family experiences and acute cortisol responses (see Repetti et al., 2011, for a review). Thus, a lack of a cortisol response to stress could be viewed as maladaptive given that it is associated with family environments that predict undesirable outcomes, such as elevated rates of externalizing behavior.

Recent work that has examined associations between adolescents' cortisol responses to stress and later externalizing behaviors in a community-based sample (not recruited on the basis of risk factors such as referrals to family services) experiencing moderate family stress suggests a more nuanced possibility (Saxbe, Margolin, Shapiro, & Baucom, 2012). The authors replicated previous findings that exposure to greater family aggression was related to smaller cortisol responses to a family conflict task in the laboratory. Family aggression was related to later antisocial behavior, but only among adolescents who showed increases in cortisol in response to the conflict task. For adolescents who showed a lack of a cortisol response to the family conflict, family aggression was not significantly related to later antisocial behavior. Although these data were cross-sectional, they suggest that inferring the (mal)adaptiveness of a particular physiological response requires information about behavioral or health outcomes.

Future Directions

Our analysis has implications for stress researchers, family researchers, and practitioners. Across the social and economic spectrum, children in the United States are exposed to a very wide range of chronic and acute stressors

both inside and outside of the home. It is clear that scientific progress in conceptualizing adaptation to normative and moderate levels of stress has been hampered by the wide variety of definitions and operationalizations of stressful events, stressful conditions, and levels of exposure that are used in different research literatures and by different groups of investigators. Common terminology and measurement strategies would make it possible for experts in the various research traditions to communicate with one other and to integrate knowledge about patterns of emotional, cognitive, behavioral, and physiological responses to different kinds of stress. In addition, assessing mental and physical health outcomes in long-term follow-up of families will be necessary to identify whether particular patterns of stress responses earlier in development predict outcomes later in life. That is the only way to advance our understanding of how stressful experiences promote resistance to future stress, what constitutes positive versus tolerable versus toxic reactions, and the psychological and biological mechanisms that explain both the beneficial and detrimental outcomes associated with different exposures to stress.

Parents not only play a critical role in determining the amount and kinds of stress to which children are exposed, but they also help shape children's responses to and recovery from stressors. It is important to identify specific family protective factors that foster tolerable responses to moderate stress as well as the parenting practices that interfere with the development of self-regulation in children by restricting their exposure to normative stressors. It can be easy to forget that not all stress is bad; indeed, exposure to stress is essential for healthy development. In a resource-rich, child-centered culture, some parents may strive to optimize their children's development by minimizing their exposure to even normative stressors and may need assistance in gauging how much is too much involvement and when to allow their children to experience, work through, and recover from the slings and arrows of everyday life.

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