Routine Versus Catastrophic Influences on the Developing Child

Candice L. Odgers[1] and Sara R. Jaffee[2]

[1]Sanford School of Public Policy and the Center for Child and Family Policy, Duke University, Durham, North Carolina 27708; email: candice.odgers@duke.edu

[2]Department of Psychology, University of Pennsylvania, Philadelphia, Pennsylvania 19104 and MRC Social, Genetic, and Developmental Psychiatry Centre, King's College London, London, SE5 8AF, United Kingdom; email: srjaffee@psych.upenn.edu

Annu. Rev. Public Health 2013. 34:29–48

First published online as a Review in Advance on January 7, 2013

The *Annual Review of Public Health* is online at publhealth.annualreviews.org

This article's doi: 10.1146/annurev-publhealth-031912-114447

Keywords

childhood adversity, toxic stress, adult health, resilience, daily stressors, differential susceptibility, early childhood intervention

Abstract

Exposure to toxic stress accelerates the wear and tear on children's developing bodies and leaves a lasting mark on adult health. Prior research has focused mainly on children exposed to extreme forms of adversity, such as maltreatment and extreme neglect. However, repeated exposure to less severe, but often chronic stressors is likely to play as large, if not larger, of a role in forecasting children's future mental and physical health. New tools from neuroscience, biology, epigenetics, and the social sciences are helping to isolate when and how the foundations for adult health are shaped by childhood experiences. We are now in the position to understand how adversity, in both extreme and more mundane forms, contributes to the adult health burden and to identify features in children's families and environments that can be strengthened to buffer the effects of toxic stressors. We are also positioned to develop and implement innovative approaches to child policy and practice that are rooted in an understanding of how exposure to toxic stressors can become biologically embedded. The stage is set for the creation of new interventions—on both grand and micro scales—to reduce previously intractable health disparities.

INTRODUCTION

Epigenetics: the study of changes in gene expression potential that occur through mechanisms that do not involve changes in DNA sequence

Adult health: refers to children's behavioral, emotional, and physical status when they reach adulthood

Toxic stress: exposure to strong, frequent, and/or prolonged adversity, typically in the absence of positive support, that carries negative consequences for most children

Childhood marks a period of unprecedented change, growth, and integration at both the biological and social level. Young children's rapidly developing brains and bodies are primed for input from the social world in ways that allow for the rapid acquisition of language, skills, and emotional competencies required for healthy development. Unfortunately, young children's enhanced sensitivity to their social environments also means they are highly susceptible to adverse childhood experiences. Countless studies have now demonstrated that children's behavioral, intellectual, mental, and physical development can vary tremendously depending on their early experiences. For example, children exposed to violence are at an increased risk for inflammation, heart disease, and respiratory difficulties in adult life (32, 33). Maltreated children are also more likely than their nonmaltreated peers (often matched on other forms of family adversity) to exhibit health-risk behaviors and mental health problems in adolescence (82) and to suffer from psychiatric disorders, poor health, and disease as adults (67). Such findings suggest that the developmental origins of adult health can be traced, in part, to childhood experiences; new evidence from molecular biology, epigenetics, and neuroscience illustrates how the nature and timing of exposure to early adversity can weaken developing brain architecture and alter a child's stress-response system (125).

Most prior research has focused on whether exposure to extreme forms of adversity (e.g., maltreatment, gross neglect, violence) influences children's future lives. However, such adversity often occurs in the context of less extreme, but ongoing stressors (e.g., cold and unsupportive interactions with parents, navigating chaotic or unsafe home or school environments), which may have equally, or perhaps even more, profound effects on children's development owing to both the frequency and the duration of their exposure. In this article, we consider the combined and relative influences on adult health of both forms of adversity in childhood. We highlight studies that have moved past the question of whether early adversity has an impact on later outcomes to test when and how adverse experiences may "get under the skin" during childhood. Throughout our review, we consider poverty and economic inequality as macrolevel forces that shape the contexts in which children experience and ultimately respond to adversity. We conclude on a somewhat hopeful note with a discussion of how resilience within children and their families may buffer the effects of adversity, and we suggest ways that these types of "ordinary magic" (97) may be leveraged to inform prevention science and public health efforts. Our review points to the benefits of improving the daily life conditions and socioemotional climate for all children—not only those at risk for extreme forms of abuse and neglect—while also emphasizing the need to enhance our understanding of how extreme forms of adversity interact with potentially toxic daily stressors to alter children's future health.

What Constitutes an Adverse Childhood Experience?

Childhood adversity has been defined in a number of ways, ranging from exposure to extreme abuse and neglect to negative emotional climates and impoverished parent-child interactions. Abuse, gross neglect, and exposure to community violence are severe and sometimes chronic adversities, the effects of which have been described as toxic to children's development (128). Yet these toxic stressors frequently occur within a context of more common, less extreme, and ongoing stressors characterized by hostility and a lack of warmth among family members, food and financial insecurity, and underresourced schools and neighborhoods, all of which have been shown to influence child and adult health status (25). We note that there is an important distinction between the mild and intermittent stressors of normal life and the more moderate (but also chronic) or severe stressors that are the focus of this article. Children cannot

be shielded entirely from the occasional failure, disappointment, or rejection, nor should they be. Indeed, animal studies show that monkeys who are "inoculated" in early life through exposure to mild, intermittent stress are less neurobiologically reactive to moderate stressors later in life and display enhanced cognitive control of their behavior into adulthood compared with monkeys who are not exposed (110, 111). Such findings are consistent with the hypothesis that mild, intermittent stressors—often referred to as positive stress—may have steeling effects on children's development (115). Throughout this review, we consider the effects of both extreme and less severe but ongoing negative stressors on adult health, acknowledging that positive stress in children's lives is likely both necessary and helpful for their development.

What Are the Long-Term Effects of Adversity on Children?

Studies have repeatedly demonstrated that severe adversity such as child abuse, neglect, and institutional deprivation increases risk for long-term behavioral, emotional, and physical health problems among exposed versus nonexposed children (23, 104, 134). More specifically, children exposed to extreme forms of adversity (*a*) often, but not always (63), exhibit worse outcomes as the dosage of exposure and/or the diversity of adverse experiences increases (19, 42, 69, 85, 115, 120); (*b*) are more likely to repeat the cycle of violence in their future relationships (36), including in the creation of a compromised caregiving environment for their own offspring (27); (*c*) are more likely to grow up within contexts characterized by poverty, harsh and unsupportive parenting, and/or underresourced schools and neighborhoods (37, 50); and (*d*) remain at increased risk for a wide range of poor outcomes in adulthood, even when they are compared with nonexposed youth living in similar types of families and neighborhoods (e.g., 135, 131).

For most children, adverse experiences are not isolated nor are they independent of one another. Children who experience one form of extreme adversity are more likely to have experienced multiple forms of adversity (37) and to be embedded in contexts where ongoing and chronic stressors are the norm (24). To capture how these experiences go together in life, investigators have taken a cumulative approach to characterize early adversity. For example, the Adverse Childhood Experiences (ACE) study has documented a robust, albeit retrospective, relationship between a cumulative history of adverse childhood experiences (including emotional, physical, or sexual abuse; neglect; family history of substance use or criminality; and divorce) and a wide range of mental and physical health problems such as suicide risk, depression, substance abuse, cardiovascular disease, and cancer (3, 39–41, 43, 45, 61, 133). Most of the findings from the ACE study have demonstrated a robust dose-response relationship between the number of adverse childhood experiences and adult health, including risk factors for the leading causes of death among adults. Similarly, work by Danese and colleagues (32) from the Dunedin Multidisciplinary Health and Development study, a cohort of 1,000 children followed prospectively from birth until age 38, illustrated how exposure to a cumulative index of adverse experiences assessed during childhood, including socioeconomic disadvantage, maltreatment (including maternal rejection, harsh discipline, and exposure to physical and sexual abuse) and social isolation—independently and cumulatively—predict depression, increased inflammatory proteins, and heightened metabolic risk in adulthood.

The use of cumulative adversity scores provides a proxy of both the severity and diversity of experiences that children encounter across childhood and in their daily lives. The creation of ACE scores and their robust associations with later health outcomes have also led some physicians to integrate assessments of childhood adversity into their routine examinations (132). Although cumulative indices provide predictive power and lend themselves to practical applications, they lack the resolution required to isolate the unique effects of specific experiences and to

Positive stress: falls within the normal range of experience and, although challenging, does not leave a lasting negative effect on the body or long-term health for most children

ACE: Adverse Childhood Experiences study

ask whether the intensity, duration, and/or timing of the experience matters with respect to altering children's developmental trajectories. As discussed below, further research that captures both long-term developmental trajectories and microlevel assessments of children's daily experiences is required to determine how repeated and complex patterns of exposure to adversity leave their mark on later health.

EVERYDAY EXPERIENCES AND THE DEVELOPING CHILD

Although ample evidence indicates that children who are maltreated are at heightened risk for a range of poor behavioral, cognitive, and mental and physical health outcomes, parenting behavior need not be abusive to have detrimental effects on children's development. Parent-child relationships characterized by ongoing hostility, low levels of warmth, and low levels of involvement may not be abusive per se but may have equally adverse consequences for children's physical and socioemotional well-being. Similarly, whereas children who suffer gross neglect are clearly developmentally delayed (116), children whose parents simply do not talk to them very much also have relatively low levels of verbal ability (75). Among adults, daily hassles such as interpersonal conflict and work stressors uniquely predict health outcomes. Daily stressors also mediate the negative effects of stressful life events when they do occur (2, 35, 88, 92). For example, the effects of a major life event may be transmitted not through the event per se, but rather through its subsequent influence on daily life. That is, a recently divorced single parent may experience more health-related problems in the wake of a divorce owing to the daily challenges of balancing work and child care responsibilities while also adjusting to increased financial pressures.

To summarize, for adults, daily hassles uniquely predict health status, often mediate (as well as moderate) the effects of stressful life events when they occur, and are often more robust predictors of poor health when compared with stressful life events. These findings are consistent with evidence from life course epidemiology showing that social causation tends to involve mundane as well as exceptional exposures (10) and illustrate the importance of considering daily stressors as one of the ways in which exposure to more extreme forms of adversity and stressful life events are translated into poor health. Although evidence for younger populations is more limited, prospective studies have typically provided stronger support for the role of chronic daily stressors versus major life events in the development of behavioral and psychological difficulties among adolescents and have also supported the mediating role of daily stressors when major life events occur (for a review, see 29); that is, the negative health effects associated with major life events can often be explained by the increase in minor stressors associated with the event versus the event per se.

Daily hassles also play an important role in shaping child care environments. For example, daily observations of parenting behaviors have found that mothering (including emotional support and engagement) is predicted by the mother's exposure to minor stressors such as workload and interpersonal conflict at work (114). In one study, on days when mothers reported more minor stressors and hassles, they were also more likely to show irritability with their children, who, in turn, were more likely to respond aggressively (112). Evidence also shows that self-reported daily environmental hassles, including life in a chaotic home, crowding, and noise exposure, are linked to diminished maternal responsiveness among low-income women (for a review, see 51).

Of course, exposure to adversity is not randomly assigned, and our ability to test whether these experiences cause later health outcomes is limited. Individuals typically report on both their perceived hassles and their health status, they select into social experiences, and they may evoke more or fewer hassles throughout the day, based on existing strengths or vulnerabilities (91). The reciprocal (endogenous) nature of stressful life events and these types of person-level factors has limited a causal interpretation

of the effects of daily hassles and major life events on later health (28, 30). Even though studies have not established causality, perceived daily hassles have consistently emerged as an important risk marker for current and future health problems. Innovation in our future research designs and intervention trials is required to bring us closer to identifying both the unique and the shared effects of extreme and more mundane exposures to adversity.

Social Stratification of Early Adversity

Poverty remains one of the most powerful determinants of whether and how children experience adversity. The highest rates of child abuse and neglect are documented among poor children (1): In-depth examinations of their daily experiences reveal remarkable differences across social class in both the quality and the quantity of interactions and experiences (52). Growing up in poverty has itself been conceptualized as a form of early adversity and has been treated as both a causal and a confounding factor when interpreting the link between childhood adversity and later health. Arguably, economic deprivation is best understood as a macrolevel force that shapes the nature and frequency of adversities and forms the context in which they are experienced, clustered, and ultimately responded to by children.

Perhaps the most famous example of the stratification of daily experiences across socioeconomic status (SES) was provided by Hart & Risley (75) in their seminal study documenting a "30 million word gap" between children living in professional versus welfare families (see sidebar, The 30 Million Word Gap). By age three, children growing up in professional families were estimated to have heard more than 30 million more words in their homes than had their peers living in families receiving welfare. Prospective assessments of these children demonstrated that this cumulative disparity in daily language exposure predicted a wide array of vocabulary, reading comprehension, and other key language-related outcomes across childhood. More recent work measuring neural functioning via electrophysiological methods has demonstrated reduced performance on prefrontal functioning among children from low- versus high-SES backgrounds. These results suggest that factors and experiences associated with SES contribute to altered prefrontal cortex functioning in ways that create deficits similar to those observed in patients with prefrontal cortex damage. This tangible effect on the brain architecture of poor children is thought to result, in part, from the deficit of supportive experiences and, in part, from the active stressors in the lives of children growing up in poverty (90).

Close observations of children growing up in poverty have also demonstrated that poor versus middle-income adolescents experience more daily-level stressors (55), particularly in the family context (e.g., negative interpersonal interactions, invasions of privacy, chaotic environments). These daily stressors, in turn, have been shown to mediate the relationship between growing up in poverty and a wide range of later outcomes (31, 68). In general, children who live day in and day out within unsupportive, impoverished, and dysfunctional social and family climates are at heightened risk for a wide range of poor outcomes, even in the absence of exposure to extreme forms of adversity (for a review, see 113). Even children who possess personal strengths (e.g., intelligence) that are advantageous under conditions of relatively low stress succumb to risk for psychopathology and other indicators of poor social and academic functioning as their

THE 30 MILLION WORD GAP

By extrapolating out from their observational data to a 100-h week, Hart & Risley estimated that the average child from a professional family would be expected to be exposed to 215,000 words of language, whereas the average child in a working-class and welfare family would be exposed to 125,000 and 62,000 words, respectively. The authors coined the phrase for their book *The Early Catastrophe: The 30 Million Word Gap by Age 3* (76) by multiplying out this dramatic difference over the four-year period of early childhood.

SES: socioeconomic status

exposure to these unsupportive and impoverished experiences increases (66, 83, 94, 119).

To summarize, just as daily hassles versus major stressful life events are as good, if not better, predictors of compromised health status among adults (2, 35, 88), the day-to-day socioemotional climate and experiences of children are emerging as powerful predictors of adjustment and health status. Exposures in childhood clearly do not have to be abusive or traumatic to have long-term effects (130). This is not to say that exposure to extreme forms of adversity is inconsequential. One only needs to look at the severe motor delays, intellectual deficits, and social deficits exhibited among children housed within institutions where extreme neglect was present to see the extent of damage that these types of experiences may cause (116). Rather, the point is to emphasize that less severe and often chronic adversities encountered by many children in their daily lives can also produce far-reaching consequences for health, regardless of whether they are accompanied by exposure to a severe life event. Moving forward, it will be important to consider how both the independent and the joint influences of extreme and less severe, but ongoing, stressors influence children's development.

Biological embedding: the ways in which social experiences are believed to alter biological processes to influence health across the life course

How Does Exposure to Both Extreme and Moderate Adversity in Childhood Influence Adult Behavior and Health?

Conversations about the relationship between early adversity and children's development are beginning to move from whether a robust link exists to how effects are transmitted across the life course. Regardless of how adverse experiences are defined or tallied, most research in this area has adopted a stress paradigm to explain how early experiences influence children's development. That is, early adversity is believed to tax children's bodies and minds in ways that induce harmful changes in their social, emotional, or behavioral functioning. More than one decade ago, Hertzman (80) coined the term biological embedding of early experiences to describe how systemic differences in the quality of early environments can tailor the chemistry of the central nervous system in ways that adversely affect cognitive, social, and behavioral development. Since this time, an explosion of research has detailed how exposure to various forms of adversity during childhood, including poverty, maltreatment, and violence exposure, can calibrate children's responsivity to stress and vulnerability to infection and disease (81, 102, 103). Numerous examples from life course epidemiology now show how the biological and developmental origins of adult disease are traced back to pathogenic processes occurring in the first several years of life (127, 129).

Risky Families and Daily Exposure to Adversity

Repetti and colleagues (113) have proposed a model to help explain how exposure to ongoing adversity within risky family contexts—characterized by conflict and aggression and by relationships that are cold, unsupportive, and neglectful—may compromise children's mental and physical health. Within this model, a vulnerable child is believed to be exposed to a cascade of repeated stressors that contribute to both early behavior problems and poor health outcomes. More specifically, repeated exposure to hostile, unsupportive, and negative interactions (although not necessarily abusive) within these families is hypothesized to lay the biological groundwork for long-term physical and mental health problems and play a central role in the biological embedding of children's daily experiences.

Past literature empirically links growing up in a risky family to high emotional reactivity, decreased social competencies, deficits in emotional understanding, and the failure to develop effective coping strategies within stressful situations (for a review, see 113). In addition to directly placing some children at risk for injury due to physical abuse and extreme neglect, repeated exposure to hostile and unsupportive interactions within the family is hypothesized to get under the skin and disrupt children's

homeostatic processes that are central to the maintenance of health (see also 135).

Biological Embedding of Routine and Catastrophic Events

Illustrations of how exposure to chronic stressors during childhood can "get under the skin" and influence biological processes are rapidly emerging in both human and animal studies (for reviews, see 10, 128). As a recent example, Essex and colleagues (49) demonstrated that, among adolescents, exposure to early-life stressors, including financial stress, role overload, parenting stress, and parental depression, likely plays a role in epigenetic processes that may affect how genes are expressed. New evidence indicates that telomeres—protective DNA sequences at the tips of chromosomes that are believed to be a marker of biological age—can shorten at a faster rate while children are experiencing stress (122). Stress in this study was marked by exposure to domestic violence, physical maltreatment, and/or bullying among children ages 5–10; those who were exposed to multiple forms of violence experienced the fastest rates of erosion. Drury et al. (38) reported similar findings among children from Romanian orphanages: Greater exposure to institutional care and severe social deprivation predicted shorter telomere length in middle childhood. Stressors may also exert both indirect and earlier effects on markers of biological aging. Reported stress among mothers during the prenatal period also predicts subsequent adult telomere length among their offspring (48).

A number of studies have documented that the limbic-hypothalamic-pituitary-adrenal (LHPA) axis/system, which controls the body's release of stress hormones such as cortisol and adrenaline, is responsive to children's experiences of stressful life events. Under normal circumstances, children and adults respond to physically and psychologically stressful situations by activating the LHPA axis, the end point of which is the stress hormone cortisol. In the short term, the LHPA axis response diverts resources to stimulate cortical arousal and increase energy. Prolonged exposure to physical or psychological stress reverses these actions, leading to decreased energy, impaired memory, and depressed mood and either hyperactivation of the LHPA axis in response to new stressors or hypoactivation of the LHPA axis (72). For example, children who experience abuse or neglect or other severe adversities tend to show a blunted cortisol response to lab-induced stressors (62, 96, 108, 109, 121), although this effect is not always observed (70). Carpenter et al. (16) observed a similar pattern in adults who were abused as children, although the effect was most evident among adults who are currently free of psychopathology (77, 78). Children who experience severe adversity also exhibit low morning cortisol levels (13), a flattened pattern of cortisol secretion across the day (9, 15; but for an exception, see 22, 71), and a less pronounced cortisol awakening response compared with children who experience more moderate adversity (74).

In contrast, less severe adversities, such as those that typically characterize children growing up in poverty, appear to be associated with elevations in basal cortisol levels (e.g., 53, 93). For example, in a community sample of kindergarten-age children, those who experienced the highest levels of cumulative adversity in the fall of their kindergarten year (encompassing family financial, parenting, and marital stressors) also showed the highest levels of basal cortisol (14). However, consistent with the hypothesis that chronic stress is associated with hypocortisolism (74), by the time these children were seen in the spring of their kindergarten year, their basal cortisol levels had dropped to below those of children experiencing average levels of adversity.

Although research has typically associated cortisol hyperreactivity with internalizing problems, such as depression and anxiety, and has typically associated cortisol hyporeactivity with children's externalizing problems, such as conduct or oppositional defiant problems (73), Boyce & Ellis (12) have proposed that these patterns may be differentially adaptive depending on context. The data on this point are mixed.

In one study, children who were bullied or maltreated had the highest levels of externalizing problems if they exhibited relatively low levels of cortisol reactivity to a lab-induced stressor (109). However, in another study, children who were exposed to high levels of family aggression had the lowest levels of externalizing problems if they exhibited relatively low levels of cortisol reactivity (121). The mixed nature of these findings points both to the need for a better understanding of how hyper- and hypocortisolism unfold over the life course—whether one gives way to the other, for instance—as well as for an integrated framework to understand children's potential stress pathways and how factors such as age, timing, severity, and duration of exposure may modify the extent to which childhood adversity leaves a lasting mark on stress responsivity and, ultimately, adult health.

The Need for a Developmental Lens

Disease-based research is beginning to adopt a developmental lens to understand the wide variation between individuals in disease progression and treatment response. For example, the immune response of basal cell carcinoma tumors has been shown to vary as a function of the patient's childhood history of emotional maltreatment and the presence of a recent stressful life event (58). A greater number of childhood adversities among breast cancer survivors also influences cellular immune function, responsiveness to treatment, and overall health (59). Interestingly, adults with supportive close relationships (versus relationships that are cold, unsupportive, and conflict ridden as described in the risky families model above) have lower levels of inflammation; new evidence indicates that troubled past relationships as well as concurrent relationships may have lasting effects on inflammation levels (57). These findings are important because persistently high levels of inflammation predict disease and are believed to be one of the ways that exposure to early and ongoing adversities influences adult health. Early experiences may calibrate later responsivity to stressful life events, whereby children exposed to early adversity will experience a heightened stress response later in life (34). However, more research is needed because relatively few studies have examined the combined influence of both extreme and less severe stressors in childhood on later health.

Taken together, such findings illustrate how exposure to cumulative stressors—ranging from extreme forms of deprivation and abuse to the day-to-day hassles of growing up within an underresourced and risky family—can get under the skin and influence children's health. Future work is required to understand how chronic and pervasive stressors may work in concert with stressful life events to compromise behavior and health across development, with an eye toward the integration of often contradictory and complex findings using well-defined theories of development. As articulated by Shonkoff (124), the challenge for the field is to focus less on refining what we already know and more on the "formulation, testing and continuous refinement of new theories of change to address significant threats in the early years of life" (p. 366). Such efforts will require a movement toward models that can account for children's diverse range of responses to adversity.

DIFFERENTIAL RESPONSE AND RESILIENCE IN THE FACE OF EARLY ADVERSITY

How children respond to adversity varies tremendously; evidence shows that individual differences are the norm rather than the exception (81). Much prior research in this area has assumed that the most vulnerable children may also be the ones who exhibit the largest negative reaction when exposed to adversity; thus, in addition to being at risk already for poor developmental outcomes, they are also more likely to experience an exaggerated response to stressors when they occur, may be more vulnerable to negative inputs from the social world, and, in effect, are likely to experience the worst of both worlds because their inherent risk factors increase both the likelihood of poor health outcomes and their susceptibility to the

adverse effects of stressful experiences on health. These types of person × environment interaction models have a long history in psychology and psychiatry and are known as diathesis-stress (105, 137) or dual risk (118) models. More recently, researchers have proposed an alternate type of person × environment interaction referred to as biological sensitivity to context (12) or differential susceptibility (8), whereby children with behavioral or genetic markers of risk are hypothesized to be the most reactive to both positive and negative experiences. Initial findings support the idea that children who carry traditional markers of risk respond "for better and for worse" (7) to their environments (5, 7, 8). For example, children who are carriers of the DRD4 7R allele (a genetic polymorphism in the dopaminergic pathway that has been linked to ADHD, substance use, and risk taking) exhibited the greatest gains in response to a randomized intervention designed to promote positive interactions and reduce antisocial behavior early in life (6). The authors concluded that "risk alleles" may not always confer risk but rather may create possibilities within intervention contexts and thus may be best conceptualized as markers for plasticity and enhanced responsiveness.

Protection in the Face of Early Adversity

Differences in the way that children experience and respond to adversity have also been tied to protective factors. Children do not respond uniformly to early adversity, and one can see impressive consistency in the specific child and family characteristics that buffer youth from the effects of toxic stressors (98). Resilience is typically defined as competence in the face of adversity (65, 95); more recent definitions emphasize the dynamic nature of resilience [e.g., "the capacity of a dynamic system to withstand or recover from significant challenges that threaten its stability, viability, or development" (99, p. 494)]. Some research has focused on individual-level characteristics that promote resilience. Children who are resilient to maltreatment, for example, tend to have high self-esteem and good self-control, tend to rely on themselves rather than others, attribute successes to their own efforts, and can flexibly adapt their behavior to changing circumstances (20, 60, 106). Some studies (79, 84), but not others (22, 44), have shown that resilient youth are more likely to have above-average intelligence compared with nonresilient youth. Other research has focused on familial and extrafamilial relationships that are protective in the face of toxic stressors such as maltreatment. For example, stable family environments are associated with resilience (44, 79), although this effect may not extend to resilience in young adulthood (44). Socially supportive relationships promote resilience (56), even among children who are otherwise genetically vulnerable (89).

It bears noting, however, that a child's ability to maintain or recover from significant adversity depends on the overall balance of risk and protective factors in the child's environment (21). For example, some studies have shown that, under conditions of extreme and ongoing stress, individual strengths fail to buffer youth from psychopathology and other negative outcomes (44, 84). A recent study of maltreated children similarly found that those who reported more (versus less) socially supportive relationships had lower levels of depression, but this protective effect was most pronounced for children with less complex maltreatment histories, presumably reflecting lower overall levels of adversity in the children's lives (117).

Safe, Stable, and Nurturing Relationships

Although much of the literature on resilience has focused on children who have been exposed to extreme adversity, a growing body of research is focused on factors that buffer children from less extreme stressors that, nevertheless, challenge children's ability to cope on a daily basis. Under these circumstances (and under more adverse circumstances, as well), children's healthy development is promoted in the context of safe, stable, nurturing relationships with caregivers and other key adults in the child's life. As defined by the US Centers for Disease Control and Prevention (18), these relationships keep children safe from physical and emotional

THE IMPORTANCE OF EARLY CHILD CARE PROVIDERS

Safe, stable, nurturing relationships inside and outside the family promote children's healthy development; thus, policy should not focus only on strengthening families, but also on enhancing training available to early child care providers, many of whom may be struggling with the same daily hassles as are the parents whose children are in their care (125). Both inside the family and in the early child care context, daily stressors may impinge on the ability of child care providers to help children master everyday challenges and cope with ongoing stressors (125). Given the potential for competence in academic, behavioral, and peer domains to have cascading effects on development (100), early intervention to strengthen families and child care systems is of paramount importance.

harm, provide predictability and consistency in the child's environment, and nurture children's developing self-confidence and sense of self-worth (see sidebar, The Importance of Early Child Care Providers). For example, safe, stable, nurturing relationships with caregivers (as well as siblings) promote resilience to being bullied by peers (11). Similarly, the degree to which the accumulation of psychosocial and physical risk factors, including family turmoil, household crowding, and family poverty, leads to wear and tear on young bodies varies as a function of the parent-child relationship. One study found that among adolescents whose mothers were relatively unresponsive to the adolescents' physical and emotional needs, accumulated adversity was associated with high levels of allostatic load, but adolescents whose mothers were more physically and emotionally responsive experienced less physiological wear and tear (54).

Allostatic load: the hormonal response to stress is adaptive for survival (allostasis), but chronic activation causes wear and tear on the body (allostatic load)

Although children—even children growing up in the same family—respond differently to adversity, and although researchers have identified a "short list" (98) of factors that characterize children who manage to withstand or successfully recover from adversity, the mechanisms by which resilience is achieved are not clearly delineated. For example, children who are bright, planful, sociable, and capable of adapting to changing circumstances may be highly successful at developing socially supportive relationships because—simply put—people like them and want to help them succeed. In the process of buffering these children from adversity, these supportive people may reduce the child's exposure to adversity as a result. In this way, two children growing up in ostensibly similar circumstances may experience those circumstances very differently. For example, the child who grows up in rural or urban poverty, but who tests well and earns a scholarship to an elite private school, will encounter a very different environment on a day-to-day basis than will the child's sibling who is less academically gifted and who may have no other choice but to attend a neighborhood school with far fewer resources.

Finally, some young people may be capable of framing their circumstances in ways that minimize the negative impacts of the adversity. This need not reflect innate individual differences in personality or coping style (although it may). Rather, as life course scientists have shown, it may simply result from the timing of the adversity in the individual's life. For example, in his seminal work on children of the Great Depression, Elder (46) showed that young people who were teenagers when the Great Depression struck were less adversely affected by their family's changing fortunes partly because many found work and achieved a sense of self-worth by contributing to the family finances. In contrast, their younger siblings who were too young to work and who were exposed to poverty at an earlier age were more adversely affected (47).

FUTURE DIRECTIONS AND UNRESOLVED ISSUES

We now have repeated examples of how both extreme and more mundane forms of adversity during childhood can leave a lasting mark on adult health. What is less clear is how the pathway from early experiences to poor adult health can be disrupted and whether children can be shielded from the long-term health effects of early adversity. Among other future

needs listed below, we first need new models to test developmental theories in action and over the course of interventions to determine how children can be shielded from experiencing toxic stressors and can be protected when adversity is present. Creative approaches are now required to test how risk and protective factors interact over time and across spheres of influence to alter children's long-term trajectories. Admittedly, it is typically neither possible nor ethical to disentangle experimentally the effects of extreme forms of adversity from the risky contexts in which these exposures typically occur. Children select into many of their environments and experiences, evoke responses from others, and may be at risk not because of the exposure to adversity per se but because of underlying common risk factors, such as shared vulnerabilities with parents who, in turn, play major roles in shaping the child's early-life experiences (64, 86). The need to rely on observational (versus experimental) research has meant a reliance on applying exhaustive statistical controls and leveraging, when possible, quasiexperimental designs to identify putative risk factors. However, new discoveries and innovative study designs now allow researchers to understand how these experiences may get under the skin to influence behavior and future health (26) and to accumulate evidence for a causal influence of toxic stressors on the developing child. Such discoveries provide the types of information required to transform the next generation of approaches into childhood policy and intervention (126).

We hope that researchers interested in the study of the effects of early adversity on later health will continue to push the boundaries of what we know about the exact nature of early adversity and later health by leveraging natural experiments and applying statistical innovations and quasiexperimental designs (86). However, it is now time to test many of the recently evolved developmental theories and findings within the context of large-scale child-, family-, school-, and community-level interventions designed to reduce exposure to both extreme and mundane forms of adversity early in life. Ideally, investigators will leverage what has been learned from the past four decades of research on the biological embedding of early adversity to produce greater impacts on childhood policy and practice. For example, new approaches have been proposed (124) to enhance the skills of adult caregivers in ways that can help young children develop effective coping skills and bring their stress-response systems back to baseline following exposure to a stressor (versus the traditional approach of providing caregivers with support and information); we also need to enhance the health-promoting characteristics of communities where vulnerable children are living (126). Armed with new data from the biological and developmental sciences, we hope that a new generation of policy and intervention strategies capable of reducing previously intractable health disparities will emerge.

Second, future research and prevention efforts will need to consider how both extreme and more minor, yet persistent, forms of adversity interact across development to place children at risk. As is true with most developmental stories, the contribution of extreme versus moderate forms of adversity is likely not an either/or proposition, but a problem that requires an integrated response to the diverse array of challenges that children encounter in their daily lives. The long-term effects of child abuse, neglect, and exposure to other extreme forms of early adversity have been well documented, and prevention efforts to minimize harm to children at risk for these experiences have a long history in intervention and prevention science. However, experiences need not be abusive or extreme to leave lasting effects on children's health (113, 130). Exposure to more minor and chronic stressors has been shown to (*a*) play a major role in shaping the caregiving environment for children, (*b*) account for most of the variance in a wide range of child outcomes, (*c*) mediate exposures to more extreme forms of adversity when they occur, and (*d*) set children up for a lifetime of altered stress responses.

The work by Fagundes and colleagues (57–59) discussed earlier in this article

provides a template for applying developmental theory—including a consideration of childhood experiences and recent stressful life events—to isolate the influence of a diverse range of adverse experiences on the onset, progression, and treatment of complex diseases. Excellent examples in psychology and human development also trace how exposure to chronic environmental stressors, such as neighborhood dysfunction and disadvantage, can exacerbate the effects of daily stressors and stressful life events among adults (17) and school-aged children (4). The challenge moving forward will be to push past the desire on the part of researchers to continue replicating the robust link between specific forms of early adversity and later health and move toward an understanding of how and under which conditions adverse experiences work in concert to leave a lasting imprint on children's lives.

Third, poverty remains the biggest threat to children's well-being, and socioeconomic gradient structures shape the extent to which children experience both extreme forms of adversity and daily stressors. Economic inequalities limit the resources available to families and communities to shield children from early adversity and to buffer the effects of adverse experiences when they occur. Innovations in targeted approaches within poor and underresourced communities are needed to begin reducing health disparities that begin early in life. Growing up in poverty increases the likelihood that children will be exposed to extreme forms of adversity and greatly influences their day-to-day socioemotional climate and experiences. Childhood SES also has lasting and independent effects on adult health, and exposure to daily stressors within these contexts is believed to be one of the main pathways through which early adversity contributes to growing inequalities in mental health, disease, and social status across the life span (for reviews, see 25, 127). Even within the wealthiest nations, the proportion and absolute numbers of children confronting the conditions associated with poverty are staggering. In the United States, an estimated 14 million children—~20% of all children—are living in families that have incomes below the federal poverty level (136). In the United Kingdom, national statistics indicate that up to 1 in 3 children (3.8 million) live in relative poverty once housing costs are considered (87). Given the pervasive problem of child poverty, and the well-entrenched inequalities within and across nations, it will be important to continue the search for factors at the family, child care, and larger system and policy levels that can buffer the effects on children of growing up in poor families and communities (125). In addition to child- and family-level interventions, we need place-based interventions that target causal mechanisms linking neighborhood-level interventions to child outcomes, including those that aim to reduce children's exposure to toxic levels of community-level stressors implicated in the biological embedding of adversity for young children, such as exposure to neighborhood violence and the absence of safe places for children to play and for parents to gather (126).

Fourth, exposure to early adversity—in both extreme and more mundane forms—is predictive but by no means deterministic of adult behavior and health. Future research needs to test how the effects of early childhood experiences influence future health (in a "for better and for worse" way) alongside efforts to identify child-, family-, and community-level factors that may moderate sensitivity to interventions and experiences early in life. At the individual level, children's responses to extreme forms of adversity vary tremendously; evidence shows that some children may be more susceptible than others. Much less is known, however, about the ways that children's responses to chronic and daily stressors differ. The idea that children who have traditionally been viewed as the most at risk may also be the most responsive to interventions that enrich early environments is one promising direction for intervention science, particularly in light of evidence that the most reactive children may also benefit the most from enriched environments and interventions (e.g., 107). Nonetheless, we need more stringent tests of this theory, including studies that include

data from children followed intensely over time to capture a full range of early experiences (see examples below). The next generation of research and intervention efforts will need to consider how individual child- (including genes and other biomarkers), family-, and larger-setting-level factors moderate the effects of experiences early in life and within intervention contexts.

Lastly, innovation in both theory and method is required to understand how both extreme adversity and ongoing daily stressors work together to influence children's future health. Mobile technologies and twenty-first-century innovations in research methods and intervention may provide the tools needed to capture the effects of daily stressors on health and to begin developing more individualized intervention approaches. As the field moves forward to consider how daily stressors and exposures during critical developmental windows may influence children's health—perhaps for better or for worse—it may be helpful to increase the resolution that is typically provided in cohort studies (where assessments often span years). Diary methods—or ecological momentary assessment (EMA) designs (123)—have been applied to capture resilience and vulnerability at the daily level among adults (2) and are now being encompassed as part of a larger movement using mobile technologies in health-based research and practice, referred to generally as mHealth (see sidebar, mHealth).

If embedded within a larger longitudinal study or used with a subset of cohort members, mobile technologies could provide the opportunity to capture the joint influences of both extreme and ongoing and chronic forms of adversity; they increase the resolution of assessments around sensitive periods of development and among especially vulnerable populations.

Mobile technologies are changing the way that we live, work, and learn. There are currently more than 6 billion cellular phone contracts worldwide, and the number is growing rapidly. Our phones keep us in constant connection, with streaming news from around the world, instant access to friends and family, and, increasingly, applications (apps) that track our location, that allow us to find the nearest hospital, or that even monitor our current blood pressure, heart rate, or steps taken throughout the day. The most rapid uptake of mobile technologies in recent years has been among low-income and often disenfranchised groups. As such, mobile technologies offer a potential means to reach families that have been traditionally difficult to engage via more traditional intervention approaches. This is not to say that mobile technologies will serve as a replacement for larger-scale and in-person interventions. However, we now have a number of examples of how mobile technologies are being used to collect high-resolution data, to share information, and to assist in the delivery of health care services and interventions globally, which could be extended to target early child care policy and practice.

We are only beginning to tap into the potential for new technologies to advance science and to identify ways that adverse events and conditions can be avoided and/or their effects minimized for children. For example, one could easily imagine a prevention program that provides new mothers with devices that contain tools to track and monitor their infant's development, communicating directly with physicians or other health care professionals, scheduling reminders for important vaccinations and well-baby checkups, locating high-quality child care services in their areas, and communicating via text message and/or video with agencies in charge of providing

mHEALTH

mHealth refers to the delivery of services and practice of medicine using mobile devices and other emerging technologies and is increasingly being viewed as an innovative way to gather data, monitor patient outcomes, and deliver health care services. mHealth approaches offer a number of opportunities to study adverse childhood experiences in daily life around the world while also presenting unique opportunities to connect children and families to resources, information, and monitoring that may eventually help to curb the long-term effects of adversity.

Sensitive period: when the effect of experience on development is especially strong for a limited period of time

services for them and their families. In the same way, adolescents, who are increasingly using mobile technologies to connect with friends and families and to build their social networks, could be reached remotely and at any time of the day to deliver adaptive health curricula tailored to their specific developmental stage and environmental stressors, and they could be easily followed—as we do in our own work—to isolate the contextual triggers and daily stressors that tend to move individuals onto a risky health trajectory. In designing twenty-first-century interventions, we can tailor interventions and services midstream (information from the devices often arrives on the researcher's or practitioner's computer screen immediately) and reach populations that may have otherwise been difficult to reach and provide them with access to services. In short, mobile technologies open up a number of potentially cost-effective opportunities around the globe for scientific discovery and for reducing health disparities and should be explored as a potential tool to understand and reduce the long-term consequences of early adversity.

SUMMARY

A compelling body of evidence now illustrates how exposure to toxic stress can accelerate the wear and tear on children's bodies and restructure the developing architecture of the brain (128). Although most prior research has focused on extreme forms of adversity and major life events, exposure to ongoing daily stressors can also be toxic by both directly influencing children as well as mediating the effects of more extreme forms of adversity when they occur. Understanding the microlevel and daily processes that shape children's development and their responses to social experiences requires a finer resolution than the science of child development has typically offered. Daily and ecological momentary assessment studies, both alone and in conjunction with larger data-collection efforts, will be required to map the pathways through which toxic stressors—of all forms—lay the foundation for children's future health. Efforts to capture the daily ebb and flow of exposure to toxic stressors in real time using mobile phones and other devices offer the potential for new discovery as well as for the implementation of individualized interventions that, ideally, could be targeted to protect children from the effects of an ongoing stressor and to provide support during sensitive periods. New approaches to developing and testing theories of change in the lives of children will be required to understand how interventions—on both a grand and a micro scale—can prevent or reduce the lasting mark of adverse childhood experiences.

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

ACKNOWLEDGMENTS

This research was supported by funding from the National Institute of Aging (AG032282), the National Institute of Child Health and Human Development (HD061298), the Economic and Social Research Council (RES-062-1583), and the Nuffield Foundation (CPF/35,191). C. Odgers is a William T. Grant Scholar.

LITERATURE CITED

1. Aber JL, Bennett NG, Conley DC, Li J. 1997. The effects of poverty on child health and development. *Annu. Rev. Public Health* 18:463–83

2. Almeida DM. 2005. Resilience and vulnerability to daily stressors assessed via diary methods. *Curr. Dir. Psychol. Sci.* 14:64–68
3. Anda RF, Croft JB, Felitti VJ, Nordenberg D, Giles WH, et al. 1999. Adverse childhood experiences and smoking during adolescence and adulthood. *JAMA* 282:1652–58
4. Attar BK, Guerra NG, Tolan PH. 1994. Neighborhood disadvantage, stressful life events and adjustment in urban elementary-school children. *J. Clin. Child Psychol.* 23:391–400
5. Bakermans-Kranenburg MJ, van Ijzendoorn MH. 2011. Differential susceptibility to rearing environment depending on dopamine-related genes: new evidence and a meta-analysis. *Dev. Psychopathol.* 23:39–52
6. Bakermans-Kranenburg MJ, van Ijzendoorn MH, Pijlman FTA, Mesman J, Juffer F. 2008. Experimental evidence for differential susceptibility: dopamine D4 receptor polymorphism (DRD4 VNTR) moderates intervention effects on toddlers' externalizing behavior in a randomized controlled trial. *Dev. Psychol.* 44:293–300
7. Belsky J, Bakermans-Kranenburg MJ, van Ijzendoorn MH. 2007. For better and for worse: differential susceptibility to environmental influences. *Curr. Dir. Psychol. Sci.* 16:300–4
8. Belsky J, Pluess M. 2009. Beyond diathesis stress: differential susceptibility to environmental influences. *Psychol. Bull.* 135:885–908
9. Bernard K, Butzin-Dozier Z, Rittenhouse J, Dozier M. 2010. Cortisol production patterns in young children living with birth parents vs. children placed in foster care following involvement of Child Protective Services. *Arch. Pediatr. Adolesc. Med.* 164:438–43
10. Boivin M, Hertzman C, eds. 2012. *Early Childhood Development: Adverse Experiences and Developmental Health*. R. Soc. Can. – Can. Acad. Health Sci. Expert Panel (with R Barr, WT Boyce, A Fleming, H MacMillan, C Odgers, M Sokolowski, N Trocmé). Ottawa, ON: R. Soc. Can. **https://rsc-src.ca/sites/default/files/pdf/ECD%20Report_0.pdf**
11. Bowes L, Maughan B, Caspi A, Moffitt TE, Arseneault L. 2010. Families promote emotional and behavioural resilience to bullying: evidence of an environmental effect. *J. Child Psychol. Psychiatry* 51:809–17
12. Boyce WT, Ellis BJ. 2005. Biological sensitivity to context: I. An evolutionary–developmental theory of the origins and functions of stress reactivity. *Dev. Psychopathol.* 17:271–301
13. Bruce J, Fisher PA, Pears KC, Levine S. 2009. Morning cortisol levels in preschool-aged foster children: differential effects of maltreatment type. *Dev. Psychobiol.* 51:14–23
14. Bush NR, Obradović J, Adler N, Boyce WT. 2011. Kindergarten stressors and cumulative adrenocortical activation: the "first straws" of allostatic load? *Dev. Psychopathol.* 23:1089–106
15. Carlson M, Earls F. 2006. Psychological and neuroendocrinological sequelae of early social deprivation in institutionalized children in Romania. *Ann. N. Y. Acad. Sci.* 807:419–28
16. Carpenter LL, Shattuck TT, Tyrka AR, Geracioti TD, Price LH. 2011. Effect of childhood physical abuse on cortisol stress response. *Psychopharmacology* 214:367–75
17. Caspi A, Bolger N, Eckenrode J. 1987. Linking person and context in the daily stress process. *J. Pers. Soc. Psychol.* 52:184–95
18. Cent. Dis. Control Prev. (CDC). 2012. *Preventing Child Maltreatment Through the Promotion of Safe, Stable, and Nurturing Relationships Between Children and Caregivers*. Atlanta, GA: CDC. **http://www.cdc.gov/ViolencePrevention/pdf/CM_Strategic_Direction–Long-a.pdf**
19. Chapman DP, Whitfield CL, Felitti VJ, Dube SR, Edwards VJ, Anda RF. 2004. Adverse childhood experiences and the risk of depressive disorders in adulthood. *J. Affect. Disord.* 82:217–25
20. Cicchetti D, Garmezy N. 1993. Prospects and promises in the study of resilience. *Dev. Psychopathol.* 5:497–502
21. Cicchetti D, Rizley R. 2006. Developmental perspectives on the etiology, intergenerational transmission, and sequelae of child maltreatment. *New Dir. Child Adolesc. Dev.* 1981:31–55
22. Cicchetti D, Rogosch FA. 2001. Diverse patterns of neuroendocrine activity in maltreated children. *Dev. Psychopathol.* 13:677–93
23. Cicchetti D, Rogosch FA, Toth SL. 2006. Fostering secure attachment in infants in maltreating families through preventive interventions. *Dev. Psychopathol.* 18:623–49
24. Cicchetti D, Toth SL. 2005. Child maltreatment. *Annu. Rev. Clin. Psychol.* 1:409–38

25. Cohen S, Janicki-Deverts D, Chen E, Matthews KA. 2010. Childhood socioeconomic status and adult health. *Ann. N. Y. Acad. Sci.* 1186:37–55
26. Cohen S, Janicki-Deverts D, Doyle WJ, Miller GE, Frank E, et al. 2012. Chronic stress, glucocorticoid receptor resistance, inflammation, and disease risk. *Proc. Natl. Acad. Sci. USA* 109:5995–99
27. Collishaw S, Dunn J, O'Connor TG, Golding J, Avon Longitud. Study of Parents and Child. Study Team. 2007. Maternal childhood abuse and offspring adjustment over time. *Dev. Psychopathol.* 19:367–83
28. Compas BE. 1987. Coping with stress during childhood and adolescence. *Psychol. Bull.* 101:393–403
29. Compas BE. 1987. Stress and life events during childhood and adolescence. *Clin. Psychol. Rev.* 7:275–302
30. Compas BE, Connor-Smith JK, Saltzman H, Thomsen AH, Wadsworth ME. 2001. Coping with stress during childhood and adolescence: problems, progress, and potential in theory and research. *Psychol. Bull.* 127:87–127
31. Conger RD, Ge X, Elder GH Jr, Lorenz FO, Simons RL. 1994. Economic stress, coercive family process, and developmental problems of adolescents. *Child Dev.* 65:541–61
32. Danese A, Moffitt TE, Harrington H, Milne BJ, Polanczyk G, et al. 2009. Adverse childhood experiences and adult risk factors for age-related disease: depression, inflammation, and clustering of metabolic risk markers. *Arch. Pediatr. Adolesc. Med.* 163:1135–43
33. Danese A, Pariante CM, Caspi A, Taylor A, Poulton R. 2007. Childhood maltreatment predicts adult inflammation in a life-course study. *Proc. Natl. Acad. Sci. USA* 104:1319–24
34. Del Giudice M, Ellis BJ, Shirtcliff EA. 2011. The adaptive calibration model of stress responsivity. *Neurosci. Biobehav. Rev.* 35:1562–92
35. DeLongis A, Coyne JC, Dakof G, Folkman S, Lazarus RS. 1982. Relationship of daily hassles, uplifts, and major life events to health status. *Health Psychol.* 1:119
36. Dodge KA, Bates JE, Pettit GS. 1990. Mechanisms in the cycle of violence. *Science* 250:1678–83
37. Dong M, Anda RF, Felitti VJ, Dube SR, Williamson DF, et al. 2004. The interrelatedness of multiple forms of childhood abuse, neglect, and household dysfunction. *Child Abuse Negl.* 28:771–84
38. Drury S, Theall K, Gleason M, Smyke A, De Vivo I, et al. 2012. Telomere length and early severe social deprivation: linking early adversity and cellular aging. *Mol. Psychiatry* 17:719–27
39. Dube SR, Anda RF, Felitti VJ, Chapman DP, Williamson DF, Giles WH. 2001. Childhood abuse, household dysfunction, and the risk of attempted suicide throughout the life span: findings from the Adverse Childhood Experiences Study. *JAMA* 286:3089–96
40. Dube SR, Anda RF, Felitti VJ, Edwards VJ, Croft JB. 2002. Adverse childhood experiences and personal alcohol abuse as an adult. *Addict. Behav.* 27:713–25
41. Dube SR, Anda RF, Whitfield CL, Brown DW, Felitti V, et al. 2005. Long-term consequences of childhood sexual abuse by gender of victim. *Am. J. Prev. Med.* 28:430–38
42. Dube SR, Fairweather DL, Pearson WS, Felitti VJ, Anda RF, Croft JB. 2009. Cumulative childhood stress and autoimmune diseases in adults. *Psychosom. Med.* 71:243–50
43. Dube SR, Felitti VJ, Dong M, Chapman DP, Giles WH, Anda RF. 2003. Childhood abuse, neglect, and household dysfunction and the risk of illicit drug use: the Adverse Childhood Experiences Study. *Pediatrics* 111:564–72
44. DuMont KA, Widom CS, Czaja SJ. 2007. Predictors of resilience in abused and neglected children grown-up: the role of individual and neighborhood characteristics. *Child Abuse Negl.* 31:255–74
45. Edwards VJ, Holden GW, Felitti VJ, Anda RF. 2003. Relationship between multiple forms of childhood maltreatment and adult mental health in community respondents: results from the Adverse Childhood Experiences Study. *Am. J. Psychiatry* 160:1453–60
46. Elder GH Jr. 1999 [1974]. *Children of the Great Depression: Social Change in Life Experience*. Boulder, CO: Westview
47. Elder GH Jr, Nguyen TV, Caspi A. 1985. Linking family hardship to children's lives. *Child Dev.* 56:361–75
48. Entringer S, Epel ES, Kumsta R, Lin J, Hellhammer DH, et al. 2011. Stress exposure in intrauterine life is associated with shorter telomere length in young adulthood. *Proc. Natl. Acad. Sci. USA* 108:E513–18
49. Essex MJ, Boyce WT, Hertzman C, Lam LL, Armstrong JM, et al. 2011. Epigenetic vestiges of early developmental adversity: childhood stress exposure and DNA methylation in adolescence. *Child Dev.* doi: 10.1111/j.467-8624.2011.01641.x

50. Evans GW. 2004. The environment of childhood poverty. *Am. Psychol.* 59:77–92
51. Evans GW, Boxhill L, Pinkava M. 2008. Poverty and maternal responsiveness: the role of maternal stress and social resources. *Int. J. Behav. Dev.* 32:232–37
52. Evans GW, Eckenrode J, Marcynyszyn LA. 2009. Chaos and the macrosetting: the role of poverty and socioeconomic status. In *Chaos and Its Influence on Children's Development. An Ecological Perspective*, ed. GW Evans, TD Wachs, pp. 225–38. Washington, DC: Am. Psychol. Assoc.
53. Evans GW, English K. 2002. The environment of poverty: multiple stressor exposure, psychophysiological stress, and socioemotional adjustment. *Child Dev.* 73:1238–48
54. Evans GW, Kim P, Ting AH, Tesher HB, Shannis D. 2007. Cumulative risk, maternal responsiveness, and allostatic load among young adolescents. *Dev. Psychol.* 43:341–51
55. Evans GW, Vermeylen FM, Barash A, Lefkowitz EG, Hutt RL. 2009. The experience of stressors and hassles among rural adolescents from low- and middle-income households in the USA. *Child. Youth Environ.* 19:1546–2250
56. Ezzell CE, Swenson CC, Brondino MJ. 2000. The relationship of social support to physically abused children's adjustment. *Child Abuse Neglect* 24:641–51
57. Fagundes CP, Bennett JM, Derry HM, Kiecolt-Glaser JK. 2011. Relationships and inflammation across the lifespan: social developmental pathways to disease. *Soc. Pers. Psychol. Compass* 5:891–903
58. Fagundes CP, Glaser R, Johnson SL, Andridge RR, Yang EV, et al. 2012. Basal cell carcinoma: stressful life events and the tumor environment. *Arch. Gen. Psychiatry* 69:618–26
59. Fagundes CP, Glaser R, Malarkey WB, Kiecolt-Glaser JK. 2012. Childhood adversity and herpesvirus latency in breast cancer survivors. *Health Psychol.* doi: 10.1037/a0028595
60. Feiring C, Taska L, Lewis M. 2002. Adjustment following sexual abuse discovery: the role of shame and attributional style. *Dev. Psychol.* 38:79–92
61. Felitti VJ, Anda RF, Nordenberg D, Williamson DF, Spitz AM, et al. 1998. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. *Am. J. Prev. Med.* 14:245–58
62. Fisher PA, Kim HK, Bruce J, Pears KC. 2012. Cumulative effects of prenatal substance exposure and early adversity on foster children's HPA-axis reactivity during a psychosocial stressor. *Int. J. Behav. Dev.* 36:29–35
63. Flaherty EG, Thompson R, Litrownik AJ, Theodore A, English DJ, et al. 2006. Effect of early childhood adversity on child health. *Arch. Pediatr. Adolesc. Med.* 160:1232–38
64. Foster EM. 2010. Causal inference and developmental psychology. *Dev. Psychol.* 46:1454–80
65. Garmezy N, Masten AS, Tellegen A. 1984. The study of stress and competence in children: a building block for developmental psychopathology. *Child Dev.* 55:97–111
66. Gerard JM, Buehler C. 2004. Cumulative environmental risk and youth maladjustment: the role of youth attributes. *Child Dev.* 75:1832–49
67. Gilbert R, Widom CS, Browne K, Fergusson D, Webb E, Janson S. 2009. Burden and consequences of child maltreatment in high-income countries. *Lancet* 373:68–81
68. Grant KE, Compas BE, Stuhlmacher AF, Thurm AE, McMahon SD, Halpert JA. 2003. Stressors and child and adolescent psychopathology: moving from markers to mechanisms of risk. *Psychol. Bull.* 129:447–66
69. Green JG, McLaughlin KA, Berglund PA, Gruber MJ, Sampson NA, et al. 2010. Childhood adversities and adult psychiatric disorders in the National Comorbidity Survey Replication I: associations with first onset of DSM-IV disorders. *Arch. Gen. Psychiatry* 67:113–23
70. Gunnar MR, Frenn K, Wewerka SS, Van Ryzin MJ. 2009. Moderate versus severe early life stress: associations with stress reactivity and regulation in 10–12-year-old children. *Psychoneuroendocrinology* 34:62–75
71. Gunnar MR, Morison SJ, Chisholm K, Schuder M. 2001. Salivary cortisol levels in children adopted from Romanian orphanages. *Dev. Psychopathol.* 13:611–28
72. Gunnar MR, Vazquez D. 2006. Stress neurobiology and developmental psychopathology. In *Developmental Psychopathology*, Vol. 2: *Developmental Neuroscience*, ed. D Cicchetti, DJ Cohen, pp. 533–77. New York: Wiley. 2nd ed.

73. Gunnar MR, Vazquez DM. 2001. Low cortisol and a flattening of expected daytime rhythm: potential indices of risk in human development. *Dev. Psychopathol.* 13:515–38
74. Gustafsson PE, Anckarsäter H, Lichtenstein P, Nelson N, Gustafsson PA. 2010. Does quantity have a quality all its own? Cumulative adversity and up- and down-regulation of circadian salivary cortisol levels in healthy children. *Psychoneuroendocrinology* 35:1410–15
75. Hart B, Risley TR. 1995. *Meaningful Differences in the Everyday Experience of Young American Children*. Baltimore, MD: Paul H. Brookes
76. Hart B, Risley TR. 2003. The early catastrophe: the 30 million word gap by age 3. *Am. Educ.* 27:4–9
77. Heim C, Newport DJ, Bonsall R, Miller AH, Nemeroff CB. 2001. Altered pituitary-adrenal axis responses to provocative challenge tests in adult survivors of childhood abuse. *Am. J. Psychiatry* 158:575–81
78. Heim C, Newport DJ, Heit S, Graham YP, Wilcox M, et al. 2000. Pituitary-adrenal and autonomic responses to stress in women after sexual and physical abuse in childhood. *JAMA* 284:592–97
79. Herrenkohl EC, Herrenkohl RC, Egolf B. 2010. Resilient early school age children from maltreating homes: outcomes in late adolescence. *Am. J. Orthopsychiatry* 64:301–9
80. Hertzman C. 1999. The biological embedding of early experience and its effects on health in adulthood. *Ann. N. Y. Acad. Sci.* 896:85–95
81. Hertzman C, Boyce T. 2010. How experience gets under the skin to create gradients in developmental health. *Annu. Rev. Public Health* 31:329–47
82. Hussey JM, Chang JJ, Kotch JB. 2006. Child maltreatment in the United States: prevalence, risk factors, and adolescent health consequences. *Pediatrics* 118:933–42
83. Jaffee SR. 2007. Sensitive, stimulating caregiving predicts cognitive and behavioral resilience in neurodevelopmentally at-risk infants. *Dev. Psychopathol.* 19:631–47
84. Jaffee SR, Caspi A, Moffitt TE, Polo-Tomas M, Taylor A. 2007. Individual, family, and neighborhood factors distinguish resilient from non-resilient maltreated children: a cumulative stressors model. *Child Abuse Negl.* 31:231–53
85. Jaffee SR, Maikovich-Fong AK. 2010. Effects of chronic maltreatment and maltreatment timing on children's behavior and cognitive abilities. *J. Child Psychol. Psychiatry* 52:184–94
86. Jaffee SR, Strait LB, Odgers CL. 2011. From correlates to causes: Can quasi-experimental studies and statistical innovations bring us closer to identifying the causes of antisocial behavior? *Psychol. Bull.* 138:272–95
87. Jin W, Joyce R, Phillips D, Sibieta L. 2010. *Poverty and Inequality in the UK: 2011*. IFS Comment. C118. London: Inst. Fiscal Stud. **http://www.ifs.org.uk/comms/comm118.pdf**
88. Kanner AD, Coyne JC, Schaefer C, Lazarus RS. 1981. Comparison of two modes of stress measurement: daily hassles and uplifts versus major life events. *J. Behav. Med.* 4:1–39
89. Kaufman J, Yang BZ, Douglas-Palumberi H, Houshyar S, Lipschitz D, et al. 2004. Social supports and serotonin transporter gene moderate depression in maltreated children. *Proc. Natl. Acad. Sci. USA* 101:17316–21
90. Kishiyama MM, Boyce WT, Jimenez AM, Perry LM, Knight RT. 2009. Socioeconomic disparities affect prefrontal function in children. *J. Cogn. Neurosci.* 21:1106–15
91. Lazarus RS. 1984. Puzzles in the study of daily hassles. *J. Behav. Med.* 7:375–89
92. Lazarus RS, DeLongis A, Folkman S, Gruen R. 1985. Stress and adaptational outcomes: the problem of confounded measures. *Am. Psychol.* 40:770–85
93. Lupien S, King S, Meaney MJ, McEwen BS. 2001. Can poverty get under your skin? Basal cortisol levels and cognitive function in children from low and high socioeconomic status. *Dev. Psychopathol.* 13:653–76
94. Luthar SS. 1991. Vulnerability and resilience: a study of high-risk adolescents. *Child Dev.* 62:600–16
95. Luthar SS, Cicchetti D, Becker B. 2003. The construct of resilience: a critical evaluation and guidelines for future work. *Child Dev.* 71:543–62
96. MacMillan HL, Georgiades K, Duku EK, Shea A, Steiner M, et al. 2009. Cortisol response to stress in female youths exposed to childhood maltreatment: results of the Youth Mood Project. *Biol. Psychiatry* 66:62–68
97. Masten AS. 2001. Ordinary magic: resilience processes in development. *Am. Psychol.* 56:227–38
98. Masten AS. 2007. Resilience in developing systems: progress and promise as the fourth wave rises. *Dev. Psychopathol.* 19:921–30

99. Masten AS. 2011. Resilience in children threatened by extreme adversity: frameworks for research, practice, and translational synergy. *Dev. Psychopathol.* 23:493–506
100. Masten AS, Tellegen A. 2012. Resilience in developmental psychopathology: contributions of the Project Competence Longitudinal Study. *Dev. Psychopathol.* 24:345–61
101. McEwen BS. 2000. Allostasis and allostatic load: implications for neuropsychopharmacology. *Neuropsychopharmacology* 22:108–24
102. Miller G, Chen E, Cole SW. 2009. Health psychology: developing biologically plausible models linking the social world and physical health. *Annu. Rev. Psychol.* 60:501–24
103. Miller GE, Chen E, Fok AK, Walker H, Lim A, et al. 2009. Low early-life social class leaves a biological residue manifested by decreased glucocorticoid and increased proinflammatory signaling. *Proc. Natl. Acad. Sci. USA* 106:14716–21
104. Miller GE, Chen E, Parker KJ. 2011. Psychological stress in childhood and susceptibility to the chronic diseases of aging: moving toward a model of behavioral and biological mechanisms. *Psychol. Bull.* 137:959–97
105. Monroe SM, Simons AD. 1991. Diathesis-stress theories in the context of life stress research: implications for the depressive disorders. *Psychol. Bull.* 110:406–25
106. Moran PB, Eckenrode J. 1992. Protective personality characteristics among adolescent victims of maltreatment. *Child Abuse Negl.* 16:743–54
107. Obradovic J, Bush NR, Stamperdahl J, Adler NE, Boyce WT. 2010. Biological sensitivity to context: the interactive effects of stress reactivity and family adversity on socioemotional behavior and school readiness. *Child Dev.* 81:270–89
108. Ouellet-Morin I, Danese A, Bowes L, Shakoor S, Ambler A, et al. 2011. A discordant monozygotic twin design shows blunted cortisol reactivity among bullied children. *J. Am. Acad. Child Adolesc. Psychiatry* 50:574–82
109. Ouellet-Morin I, Odgers CL, Danese A, Bowes L, Shakoor S, et al. 2011. Blunted cortisol responses to stress signal social and behavioral problems among maltreated/bullied 12-year-old children. *Biol. Psychiatry* 70:1016–23
110. Parker KJ, Buckmaster CL, Lindley SE, Schatzberg AF, Lyons DM. 2012. Hypothalamic-pituitary-adrenal axis physiology and cognitive control of behavior in stress inoculated monkeys. *Int. J. Behav. Dev.* 36:45–52
111. Parker KJ, Rainwater KL, Buckmaster CL, Schatzberg AF, Lindley SE, Lyons DM. 2007. Early life stress and novelty seeking behavior in adolescent monkeys. *Psychoneuroendocrinology* 32:785–92
112. Patterson GR. 1983. Stress: a change agent for family process. In *Stress, Coping, and Development in Children*, ed. N Garmezy, M Rutter, pp. 235–64. New York: McGraw-Hill
113. Repetti RL, Taylor SE, Seeman TE. 2002. Risky families: family social environments and the mental and physical health of offspring. *Psychol. Bull.* 128:330–66
114. Repetti RL, Wood J. 1997. Effects of daily stress at work on mothers' interactions with preschoolers. *J. Fam. Psychol.* 11:90–108
115. Rutter M. 1979. Protective factors in children's responses to stress and disadvantage. *Ann. Acad. Med. Singapore* 8:324–38
116. Rutter M. 1998. Developmental catch-up, and deficit, following adoption after severe global early privation: English and Romanian Adoptees (ERA) Study Team. *J. Child Psychol. Psychiatry* 39:465–76
117. Salazar AM, Keller TE, Courtney ME. 2011. Understanding social support's role in the relationship between maltreatment and depression in youth with foster care experience. *Child Maltreat.* 16:102–13
118. Sameroff AJ. 1983. Developmental systems: contexts and evolution. In *Handbook of Child Psychology*, Vol. 1, ed. P Mussen, pp. 237–94. New York: Wiley
119. Sameroff AJ, Bartko WT, Baldwin A, Baldwin C, Seifer R. 1998. Family and social influences on the development of child competence. In *Families, Risk, and Competence*, ed. M Lewis, C Feiring, pp. 161–85. Mahwah, NJ: Lawrence Erlbaum
120. Sameroff AJ, Chandler MJ. 1975. Reproductive risk and the continuum of caretaking casualty. In *Review of Child Development Research*, Vol. 4, pp. 187–244. Chicago: Univ. Chicago Press
121. Saxbe DE, Margolin G, Spies Shapiro LA, Baucom BR. 2012. Does dampened physiological reactivity protect youth in aggressive family environments? *Child Dev.* 83:821–30

122. Shalev I, Moffitt T, Sugden K, Williams B, Houts R, et al. 2012. Exposure to violence during childhood is associated with telomere erosion from 5 to 10 years of age: a longitudinal study. *Mol. Psychiatry* doi: 10.1038/mp.2012.32
123. Shiffman S, Stone AA, Hufford MR. 2008. Ecological momentary assessment. *Annu. Rev. Clin. Psychol.* 4:1–32
124. Shonkoff JP. 2010. Building a new biodevelopmental framework to guide the future of early childhood policy. *Child Dev.* 81:357–67
125. Shonkoff JP. 2011. Protecting brains, not simply stimulating minds. *Science* 333:982–83
126. Shonkoff JP. 2012. Leveraging the biology of adversity to address the roots of disparities in health and development. *Proc. Natl. Acad. Sci. USA* 109(Suppl. 2):17302–7
127. Shonkoff JP, Boyce WT, McEwen BS. 2009. Neuroscience, molecular biology, and the childhood roots of health disparities: building a new framework for health promotion and disease prevention. *JAMA* 301:2252–59
128. Shonkoff JP, Garner AS, Siegel BS, Dobbins MI, Earls MF, et al. 2012. The lifelong effects of early childhood adversity and toxic stress. *Pediatrics* 129:e232–46
129. Shonkoff JP, Philips DA, eds. 2000. *From Neurons to Neighborhoods: The Science of Early Childhood Development*. Washington, DC: Natl. Acad. Press
130. Taylor SE, Way BM, Seeman TE. 2011. Early adversity and adult health outcomes. *Dev. Psychopathol.* 23:939–54
131. Thornberry TP, Henry KL, Ireland TO, Smith CA. 2010. The causal impact of childhood-limited maltreatment and adolescent maltreatment on early adult adjustment. *J. Adolesc. Health* 46:359–65
132. Tough P. 2011. The Poverty Clinic: Can a stressful childhood make you a sick adult? *New Yorker Mag.* March 21:25–32
133. Whitfield CL, Anda RF, Dube SR, Felitti VJ. 2003. Violent childhood experiences and the risk of intimate partner violence in adults: assessment in a large health maintenance organization. *J. Interpers. Violence* 18:166–85
134. Widom CS, Czaja SJ, Bentley T, Johnson MS. 2012. A prospective investigation of physical health outcomes in abused and neglected children: new findings from a 30-year follow-up. *Am. J. Public Health* 102:1135–44
135. Widom CS, DuMont K, Czaja SJ. 2007. A prospective investigation of major depressive disorder and comorbidity in abused and neglected children grown up. *Arch. Gen. Psychiatry* 64:49–56
136. Wight VR, Chau M, Aratani Y. 2010. *Who Are America's Poor Children?: The Official Story*. New York: Natl. Cent. Child. Poverty (NCCP). **http://www.nccp.org/publications/pdf/text_912.pdf**
137. Zuckerman M. 1999. *Vulnerability to Psychopathology: A Biosocial Model*. Washington, DC: Am. Psychol. Assoc. 1st ed. 535 pp.

RELATED RESOURCES

Center on the Developing Child at Harvard University (Cambridge, MA): **http://developingchild.harvard.edu/**

Sackler Colloq. 2012. *Biological Embedding of Early Social Adversity: From Fruit Flies to Kindergartners* (Arthur M. Sackler Colloquia). *Proc. Natl. Acad. Sci. USA* 109(Suppl. 2):17143–308. **http://www.pnas.org/search?fulltext=Biological+Embedding+of+Early+Social+Adversity%3A+From+Fruit+Flies+to+Kindergartners+Sackler+Colloquium&submit=yes**