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Special Issue Article

Emergence and evolution of developmental resilience science over half a century

Ann S. Masten
University of Minnesota Twin Cities, Minneapolis, MN, USA

Abstract

This reflection on the history and future of developmental resilience science (DRS) highlights its co-emergence with developmental psychopathology (DP), as well as the roles of this journal and its founding editor, Dante Cicchetti, in the evolution of these intertwined domains of scholarship. A remarkable constellation of scholars at the University of Minnesota shaped the course of both conceptual frameworks and their dissemination. I describe fundamental assumptions common to DP and DRS frameworks that reflect their common roots and the pervasive influence of systems theory on developmental science. I describe four waves of DRS and key principles of DRS at the present time. In conclusion, I consider the possibility that a fifth wave of DRS is emerging with a focus on understanding patterns of multisystem, multilevel processes of resilience and their implications for interventions in the context of interacting, interdependent, and complex adaptive systems. I close this commentary with questions for future research and a hopeful outlook on the future of human resilience.

Keywords: Adaptation; multisystem; promotive; protective; resilience

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Introduction

Developmental psychopathology (DP) and developmental resilience science (DRS) co-emerged during the 1970s (Masten & Cicchetti, 2016; Masten et al., 1990). A remarkable network of scholars concentrated at the University of Minnesota (UMN) influenced many of the core ideas common to these interrelated domains of developmental science. These ideas spread widely over the ensuing decades through the activities of their students and colleagues. The proximity of two distinct departments of psychology at UMN played a central role, with faculty and students in the Department of Psychology (in Elliott Hall) and the Institute of Child Development (ICD, next door) interacting in courses, colloquia, and collaborative research, as well as at parties and in the cafeteria located between the two buildings (in Shevlin Hall). Many students training in clinical and developmental psychology during the 1970s took courses taught by Thomas Bouchard, James Butcher, Norman Garmezy, Irving Gottesman, David Lykken, Paul Meehl, and Auke Tellegen in Psychology as well as William Charlesworth, Andrew Collins, Willard Hartup, and Alan Sroufe in ICD, among others. Byron Egeland and Richard Weinberg, initially faculty in Elliott Hall, moved to ICD as the two departments launched a joint training program in clinical child psychology. This specialty track, more formally known as the Developmental Psychopathology and Clinical Science program, combined training in clinical psychology and developmental science.

Email: amasten@umn.edu

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The network that gave momentum to DP as well as DRS included close colleagues of UMN faculty at other universities, such as Jeanne and Jack Block, Mavis Hetherington, Gerald Patterson, Michael Rutter, Arnold Sameroff, and Edward Zigler. This network of mentors trained a host of students in DP and DRS, both at UMN (e.g., Thomas Achenbach, Dante Cicchetti, Judy Garber, Margaret O'Dougherty Wright) and elsewhere, such as Yale (e.g., Suniya Luthar). These students, in turn, disseminated developmental models of psychopathology and resilience through their own scholarship and mentoring over the years, resulting in a new generation of scholars with developmental perspectives on psychopathology and resilience. Many of these descendants are represented in this special issue honoring the seminal role of Dante Cicchetti in establishing DP as a distinct and cohesive, multidisciplinary developmental framework for research on pathways toward and away from psychopathology. Cicchetti exemplifies the extraordinary legacy of UMN graduate training at UMN during the 1970s, mentored by faculty in clinical psychology, including Paul Meehl and Norman Garmezy, as well as in developmental psychology, including Alan Sroufe. Cicchetti's integrative vision of DP would have transformative consequences for multiple domains of science, including resilience research.

Under Cicchetti's leadership, a special issue he edited of *Child Development* set the early course for DP (Cicchetti, 1984). In 1987, Cicchetti held the first in a series of symposia on DP in Rochester, New York, while he was on the faculty at the University of Rochester. The Rochester Symposia on DP (modeled on the Minnesota Symposia on Child Psychology), led to a series of edited books based on this annual conference (see Cicchetti, 1989). The growth and influence of DP was further spurred by a series of literally and figuratively hefty, multivolume books entitled

Developmental Psychopathology that Cicchetti edited in collaboration with child psychiatrist Donald Cohen, the renowned Director of the Yale Child Study Center, from 1995 until Cohen's untimely death. The most recently edition of this compendium includes four large volumes, solo edited by Cicchetti (2016).

One of the core features of DP as championed by Cicchetti was the attention to positive pathways and adaptive processes as well as pathways to psychopathology and maladaptive functioning. For the 1984 special issue of *Child Development*, Cicchetti invited a paper focused on resilience (Garmezy et al., 1984). For the first Rochester Symposium in 1987 on DP, he included me as a speaker and I subsequently wrote a chapter on resilience (Masten, 1989) for the ensuing first volume stemming from that initial symposium. All three of the editions of *Developmental Psychopathology* edited by Cicchetti included the topic of resilience (Luthar, 2006; Masten & Coatsworth, 1995; Masten & Cicchetti, 2016).

Development and Psychopathology, the journal Cicchetti founded in 1989, has continued to play a vital role in the ongoing evolution of DRS, with numerous articles and special issues highlighting theory and research on DRS. The most cited article to date in the journal is a review of the first generation of resilience research (Masten et al., 1990). Additionally, there have been three important special issues on resilience over the past three decades: "Milestones in the Development of Resilience" (Cicchetti & Garmezy, 1993), "A Multilevel Approach to Resilience" (Cicchetti & Curtis, 2007); and most recently, "Resilience in Development: Pathways to Multisystem Integration" (Masten et al., 2023). As a result of this journal and Cicchetti's other influential publications, Cicchetti's influence in the advancement and dissemination of DRS cannot be overestimated.

Shared assumptions and concepts of DP and DRS

Given their closely intertwined origins, it is not surprising that DP and DRS share fundamental assumptions (Masten & Cicchetti, 2016). These ideas reflect the profound influence of developmental systems theory as well as a growing body of research with implications for both domains, such as studies of gene–environment interplay, developmental neurobiology, and the effects of context and trauma on development (Bronfenbrenner & Morris, 2006; Cicchetti & Rogosch, 1996; Cicchetti, 2006, 2013; Cicchetti & Toth, 2009; Cummings & Valentino, 2015; Egeland et al., 1993; Garmezy & Rutter, 1983; Gottesman, 1974; Gottlieb, 2007; Lerner, 2006; Masten & Cicchetti, 2010; Masten, 2007; Masten & Kalstabakken, 2018; Meaney, 2010; Sameroff, 2010; Overton, 2013; Sroufe & Rutter, 1984; Sroufe et al., 2005; Zelazo, 2013).

Examples of guiding themes shared by DP and DRS, likely due to their common roots and interactions, include the following (Masten & Cicchetti, 2016; Masten & Kalstabakken, 2018).

- Understanding variations and change in adaptive behavior over the life course requires a developmental perspective.
- Living systems are self-organizing with emergent properties that can be surprising or unpredictable from lower levels of analysis.
- Development is shaped by many interacting systems within and around the organism and these interactions are multidirectional.
- Behavior emerging from multisystem and multilevel interactions over time can be described as a pathway.
- As a result of ongoing multisystem interactions and experiences, developmental pathways can converge from disparate origins (equifinality) or diverge from similar origins (multifinality), resulting in many pathways toward or away from positive adaptation or psychopathology.
- Development is probabilistic rather than deterministic.
- Developmental timing of experiences can have differential effects on development.
- Plasticity of individuals with regard to the effects of experiences varies over the course of development.
- Judgments about the quality of adaptation are typically based on expectations about human development and behavior (e.g., developmental tasks or behavioral norms) that are influenced by context, culture, and history, and thus vary over time and context.
- Knowledge of positive development and psychopathology are mutually informative for theory, prevention, and treatment.

Four waves of developmental resilience science

Research on resilience in human development began in earnest during the 1970s. When scholars reflected on the history of DRS after three or more decades of research, they delineated four distinct waves or phases of research (Masten et al., 2023; Masten, 2021; Wright et al.., 2013). The first wave was largely descriptive, as investigators sought to identify the correlates and predictors associated with better adaptation following exposure to significant adversity or high-risk circumstances. This wave underscored the idea that operationalizing the study of resilience required two basic judgments and corresponding measurement strategies for assessing threats and outcomes in human adaptation and development: (1) exposure to risks or challenges that threatened adjustment or development and (2) criteria for judging how well the person was doing in the aftermath of this risk or adversity exposure (Luthar et al., 2000; Masten & Coatsworth, 1998; Masten et al., 2023). The key aim of early studies was to identify predictors of good or relatively better adaptation among groups of individuals exposed to significant threats or risk factors known to pose potential harm to function or development –in other words, to answer a question motivating much of this research: *What makes a difference?* Scholars hoped to identify key factors and processes associated with better adaptation to adversity, with the ultimate translational objective of fostering adaptive responses to adverse life experiences and informing interventions to facilitate resilience.

Eventually, the descriptive literature identified two major kinds of resilience factors associated with good or better outcomes in the context of risk, classified by the nature of their effects (Masten, 2001). Promotive factors (Sameroff, 2000) – also called compensatory factors (Garmezy et al., 1984) or simply assets – referred to predictors showing generally positive effects on adjustment: in statistical terms, positive main effects on outcome criteria. Protective factors referred to predictors showing mitigating or buffering effects, reducing negative effects associated with risk indicators on the adjustment outcome variables of interest: in statistical terms, moderating effects on risk (consistent with greater effects when risk is high, over and above any main effects that might be observed at low as well as high-risk conditions). It was recognized early in DRS that the same variable or attribute (of the person or their environs) could have varying effects depending on the adjustment criteria, timing, or circumstances (Rutter, 1987). However, elucidating these variations proved to be complex and important in the ensuing years. Of particular note is the concept of differential susceptibility or sensitivity to experience (Ellis et al., 2011), where the effects of a particular attribute appear to depend on whether the environmental conditions are advantageous or adverse, with observable effects of the same attribute varying from negative to positive depending on the favorability of the environment. Sensitive people, who appear to be particularly

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vulnerable to adversity, may also be more responsive to favorable experiences and possibly also to interventions (Bakermans-Kranenburg & van IJzendoorn, 2015).

Diverse research on resilience has suggested a consistent "short list" of widely observed resilience factors associated with better adapting in children and youth who were faced with adversity, presumably reflecting fundamental human adaptive systems and processes that arose through processes of biological and cultural evolution (Masten, 2001, 2007). Over the years, considerable support has accrued for many of these resilience factors, as reported in narrative reviews (e.g., Doom et al., 2023; Mesman et al., 2021; Ungar & Theron, 2022), systematic reviews (e.g., Gartland et al., 2019; Meng et al., 2018;) and many other reports focused on specific populations or situations (e.g., Arakelyan & Ager, 2021; Marquez et al., 2023; Werner, 1993, 2012). Evidence continues to accumulate in support of the idea that human resilience depends substantially on ordinary human adaptive systems that often were implicated in early descriptive studies. Over time, however, the focus of research shifted from the "what questions" of descriptive identification to "how questions" in a search for deeper understanding of resilience processes (Masten et al., 1990, 2023). Subsequently, in later phases of resilience science, investigators noted compelling similarities in resilience factors identified in systems studied at different levels of analysis (e.g., family, community), described further below.

When the focus of resilience studies shifted from *what* to *how*, the second wave of DRS began. This wave of theory and research emphasized resilience as a complex process (or set of processes) and also aligned DRS more closely with a broader transformation in developmental science toward systems thinking (Masten et al., 2023). The infusion of systems theory in studies of human development transformed general developmental science and DP as well as DRS. The shared assumptions of DP and DRS listed above reflect this transformation. Efforts to investigate processes of adaptation in the wake of adversity also focused attention on the need for better methods to measure dynamic change over time. Interest surged in concepts focused on dynamic patterns of change over time, such as pathways and trajectories (e.g., Betancourt & Khan, 2008; Bonanno, 2004; Masten & Powell, 2003; Sroufe et al., 2005), equifinality and multifinality (Cicchetti & Rogosch, 1996), and developmental cascades (Masten & Cicchetti, 2010). The second wave also brought greater attention to the roles of context and culture in resilience processes (Masten et al., 2023; Panter-Brick, 2015; Ungar, 2008; Wright et al., 2013).

In the search for better understanding of resilience processes, both promotive and protective effects of resilience factors observed in longitudinal studies held special interest as potential clues to how resilience might work. Potentially malleable resilience factors were particularly important to investigators who had intervention in mind, with the goal of fostering better adaptation in the aftermath of adversity, or prevention in the form of building protection against future adversity. The third wave of DRS began when investigators started to test the possibilities of fostering resilience through intervention studies aiming to mitigate risk, enhance protection, or favorably alter mediators of risk/adversity in the lives of children and their families.

From the outset of DRS, a central goal of investigators was gaining knowledge to guide practice and policy (Masten, 2011). This was not surprising, given that many of the pioneers who led the way were trained in clinical fields, including Garmezy (clinical psychology) and Rutter (psychiatry). As knowledge accumulated about the processes that appeared to counter or mitigate the risks associated with adversity, there was a surge in intervention research that could simultaneously test the causal models emerging from the first two waves of DRS while also offering help to children or their families potentially affected by adverse experiences. Intervention studies of resilience represent the third wave of DRS, with randomized controlled trials (RCTs) and quasi-experimental designs offering the most compelling tests of resilience theory about processes of resilience.

These studies generally reflect three basic strategies of intervention suggested by this author and others based on resilience frameworks, targeting risk, promotive, or protective processes (Masten, 2011). Some interventions focus on lowering risk or adversity exposure, for example by preventing maltreatment (e.g., van IJzendoorn et al., 2020). Others focus on adding supportive or promotive resources to the lives of children, such as cash transfers to impoverished families with children (e.g., Troller-Renfree et al., 2022). During the COVID-19 pandemic, many schools as well as local, state, and federal government agencies acted to provide additional resources for children to promote health and learning, including food and technology needed for distance learning. Long before the pandemic, schools played a central role in designing and testing resilience-based interventions of many kinds and also served as a setting for interventions, perhaps because schools are not only accessible to most children and families, but also because schools are perceived as a normal and safe environment by families and communities alike. Dray and colleagues (2017) reviewed the literature on universal resilience-focused interventions targeting mental health in children and youth in school settings.

Interventions focused on protective processes for children and youth often have targeted parenting or parent–child relationships (Sandler et al., 2015; Toth et al., 2013) and youth mentoring (Raposa et al., 2019). Robust evidence, for example, has accumulated in support of interventions that enhance the quality of caregiving and parenting skills in the families of children at risk due to adverse experiences or toxic environments, supporting basic research findings on the protective effects of effective and supportive family care against risks posed by various forms of adversity in childhood (Doty et al., 2017; Masten & Cicchetti, 2016; Masten & Palmer, 2019). Cicchetti, Toth, and collaborators at the Mt. Hope Family Center, for example, have conducted rigorous RCTs on preventive interventions to test the effects of infant–parent psychotherapy and other parenting interventions on secure attachment relationships in maltreating families and also in families where the mother has a diagnosis of Major Depressive Disorder (e.g., Cicchetti et al., 2006; Toth et al., 2006). Fisher and colleagues (2007) demonstrated through an RCT that a family-based therapeutic foster care intervention (in comparison with routine foster care) showed protective effects against dysregulated diurnal cortisol patterns of activity associated with stress. Sandler, Wolchik, and their colleagues have demonstrated in another RCT (with multiple follow-ups) the short- and long-term effects of a preventive parenting intervention for bereaved families (loss of a parent), providing evidence of intergenerational effects on parenting attitudes as well as shorter-term effects on parenting and youth behavior (Rhodes et al., 2023). Such RCTs offer compelling evidence that parent–child relationships central to theories of psychopathology and resilience in DP and DRS are malleable, with potentially cascading effects (Masten & Cicchetti, 2016).

In addition to supporting specific hypotheses about resilience, intervention research also has suggested that it is effective to combine multiple approaches, coordinated (stacked or aligned) to create synergy (Cicchetti, 2013; Hostinar & Miller, 2019; Masten,

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2011, 2014; Wyman et al., 2000; Yoshikawa, 1994). The humanitarian sector of international aid and development has played a leading role in demonstrating the power of coordinated multi-sector, multi-generational, and/or multilevel interventions for child well-being in populations of children at high risk due to extreme poverty, armed conflicts, famine, and natural disasters (Britto et al., 2017; Huebner et al., 2016; Panter-Brick, 2023; Richter et al., 2017). Synergistic effects of coordinated multi-sector and/or multilevel strategies are not surprising given early observations in the literature on risk and resilience that children in situations of high threat or deprivation often face multiple and accumulating risks (Rutter, 1979; see Masten et al., 1990). Cumulative risk situations appear to benefit from cumulative protection (Masten, 2001; Morris et al., 2021; Wyman et al., 2000; Yoshikawa, 1994).

By the time I wrote a commentary on the state of DRS for a resilience-focused special issues of this journal (Masten, 2007), it was clear that a new wave of work was emerging; hence the title: "Resilience in Developing Systems: Progress and Promise as the Fourth Wave Rises." The shift in DRS to full-blown systems theory had taken hold while at the same time, powerful new methods of research and analysis made it possible to study resilience at multiple levels of analysis, spanning genes to socioecological contexts (Masten et al., 2021). In addition, multisystem catastrophes, including 9–11 in 2001, the tsunami in 2004 triggered by an earthquake in the Indian Ocean, and Hurricane Katrina in 2005, underscored the necessity of understanding resilience at macrosystem levels (e.g., city, region, country) as well as in individuals and families (Masten, 2014). A fourth wave was emerging with a focus on multiple levels of functioning and the dynamics of adaptation.

My views about resilience at this time were profoundly influenced by interactions with researchers studying disasters, including work with Joy and Howard Osofsky before and after Hurricane Katrina, and interactions with multidisciplinary researchers studying resilience. Beginning in 2005, I was part of a small network on "Building an Interdisciplinary Study of Resilience" (Longstaff, 2009), funded by the US National Science Foundation as part of their Human Dynamics initiative. Our goal was to pave the way for integrating theory and findings on resilience from disparate disciplines, including ecology, psychology, immune function, communications, computer engineering, and urban planning, in order to improve disaster preparation and responses. It quickly became apparent that this goal required better aligning of our definitions of resilience as well as embracing systems thinking. Discussing disaster scenarios, such as a pandemic or natural disaster, helped us learn to communicate. This experience motivated me to adopt a definition of resilience applicable to complex adaptive systems that I thought would be portable and scalable across levels of analysis and disciplines. Thus, I began to define resilience broadly in the following or similar terms: "the capacity of a dynamic system to adapt successfully to significant challenges that threaten the function, survival, or development of the system" (Masten, 2007, 2011, 2014, 2018, 2021; Masten & Obradović, 2008).

The fourth wave in DRS rose in conjunction with multilevel research in DP as advancing theory and new research tools made it possible to study more complex processes linking different levels of interaction that were shaping the course of development (Cicchetti & Curtis, 2007; Masten & Cicchetti, 2016). Multisystem research was spurred, for example, by accessible tools for measuring function and change in activities of genes, neurobiological stress regulation systems, brain function and circuitry, immune function, cognitive and emotional self-regulation, family dynamics, behavior, community supports and other complex systems, both in labs and in the field, in the context of intervention studies as well as observational studies; and also by powerful analytic tools for testing more dynamic and complex models of psychopathology and resilience (Masten et al., 2023; McEwen, 2020; McLaughlin et al., 2020; Ungar, 2018).

The fourth wave highlighted multisystem influences on resilience, underscored the dynamic nature of resilience, and brought much greater attention to resilience processes at both micro and macro levels of analysis. Studies of neurobiological as well as cultural influences surged. Research on the neurobiology of resilience blossomed when the tools for reliable assessments of processes within the human body became more feasible, including assessments of stress biology, gene methylation, immune function, and brain function (Feder et al., 2019; Feldman, 2021; Gunnar, 2020; Masten & Cicchetti, 2016; McEwen, 2020; McLaughlin et al., 2020; Shonkoff et al., 2021). Research focused on sociocultural processes, acculturation, discrimination, social justice, and historical trauma gained more attention (e.g., Jones et al., 2023; Marks et al., 2020; Murry et al., 2023; Panter-Brick, 2023; Spencer, 2023; Motti-Stefanidi, 2023; Suárez-Orozco et al., 2018; Wilbur & Gone, 2023). Multisystem measures of protective factors became prominent, such as the Child and Youth Resilience Measure (Ungar & Liebenberg, 2011) and indices of positive (rather than adverse) childhood experiences, such as the Benevolent Childhood Experiences scale (Narayan et al., 2023). The 2023 special issue of this journal on multisystem resilience highlights major themes in the fourth wave of DRS (Masten et al., 2023).

The COVID-19 pandemic undoubtedly stimulated broad interest in resilience, accelerated adoption of multisystem models in resilience theory, and led to a host of new research on resilience in the wake of this global catastrophe. Prime and colleagues (2020), for example, proposed a multisystem Family Disruption Model on the effects of risk and protective processes during the pandemic. In short order, Shoychet and colleagues conducted a systematic review of publications testing the model (Shoychet et al., 2023). Masten and Motti-Stefanidi (2020) proposed in a paper on resilience during the pandemic that the "short list" of resilience factors identified earlier in DRS through an individual resilience lens, were observable at other system levels, in the literature on resilience in family, school, and community systems. The striking alignment of resilience factors across system levels suggested that the capacities associated with resilience in these interacting systems reflect interconnected processes that likely co-evolved, providing far more potential for resilience in human adaptation and development than individuals would be able to muster on their own. We argued that the resilience of children to current threats depends heavily on resilience of key systems in their lives, which also serve to nurture future resilience in children.

Resilience in the context of complex multisystem calamities – like a pandemic or the disasters associated with climate change – require multisystem responses, evidenced around the world during the COVID-19 pandemic. Resilience was mobilized and often bolstered at virtually every level of human adaptive function, ranging from immune function or individual problem-solving to the operations of families, schools, healthcare systems, manufacturing, and research teams, as well as governmental and humanitarian agencies. Impressive successes and disturbing gaps were revealed in the pandemic response across many systems and also in the coordination of multisystem responses (or its lack). Hopefully, lessons will be carried forward to disaster planning and preparation

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at every system level for future challenges, including the looming crises posed by climate change (Sanson & Masten, 2023).

The pandemic also highlighted the dynamic nature of resilience during an extended and complex disaster and, concurrently, the challenges in modeling change in complex adaptive systems that are continually interacting. The pandemic had a "roller coaster" quality, not only in regard to the waxing and waning prevalence rates of infection, but also in terms of perceived resilience and adaptive functioning by individuals coping with pandemic challenges (Masten, 2021; Walsh, 2020). Parents, for example, could surge capacity to support and protect their children during difficult periods of lock-down, at least for some period of time, but parents also reported periods of feeling depleted or exhausted as the pandemic unfolded (He et al., 2021). The idea that resilience fluctuates between surges and depleted capacity underscores the limitations of simple pathway models of resilience that were popular during earlier times. In addition, the goal of assessing roller-coaster patterns in research on resilience demands better methods for capturing dynamic patterns of resilience and adaptive functioning over time in complex adaptive systems.

There certainly are additional signs of progress in the effort to study multisystem processes with strategies that embrace the complexity of multisystem thinking about resilience (Ioannidis et al., 2020; Masten et al., 2023). In the recent special issue of this journal on multisystem resilience, Hasselman (2023) described a toolbox of methods that hold promise for meeting the assumptions of what he terms "strong complexity" models. Nonetheless, collecting empirical data suitable for these methods can be daunting. Additional signs of progress can be found in papers applying network analysis to capture patterns of coordinated resilience resources or processes (e.g., Höltge et al., 2021; Ungar et al., 2023) or linked patterns of stressors, symptoms, and resilience factors (e.g., Kalisch et al., 2019); multilevel latent class analysis to identify profiles of linked risks, assets, services, and/or adaptive behavior (e.g., Cutuli et al., 2023) or multiple trajectory models (e.g., Wiglesworth et al., 2023). Nevertheless, multisystem theory about resilience remains substantially ahead of the empirical evidence to date on the patterns and processes of integrated multisystem resilience.

Principles of DRS at the present time

Contemplating the central ideas characterizing DRS at the present time, well over a decade after signs of the fourth wave emerged, the following ten principles stand out to me.

1. DRS is focused on understanding potential and manifested human capacity to respond effectively to major life challenges over the life span, the processes involved, how such capacity develops, and how it can be nurtured and supported.

2. Human resilience is emergent: As in human development more broadly, resilience arises from many processes that span systems and levels of function, biological through ecological.

3. Resilience reflects the properties of a complex adaptive system and its interactions with many systems within and around the individual or social system of interest (e.g., family, community).

4. Resilience changes over multiple time scales, ranging from evolutionary and historical to developmental to short-term or momentary intervals.

5. Resilience changes as a function of development, experience, context, and ongoing multisystem interactions.

6. Many of the systems and processes involved in human resilience are malleable and therefore potentially open to change through nurturing, socialization, intervention, or related efforts to enhance resilience.

7. Due to the many processes involved in human resilience, there are many possibilities for intervention at different levels and through varying processes, although effects will vary depending on leverage, timing, and so forth.

8. Resilience, as with other complex processes in human functioning, can cascade across domains, levels, cultures, and generations.

9. Major engines of resilience reflect fundamental human adaptive systems widely observed across cultures although there also are unique protective factors observed in specific situations or cultures.

10. Similar and analogous resilience factors and processes are observed at multiple system levels, from the individual or family level to the cultural or community level, suggesting that fundamental human adaptive systems co-evolved at multiple system levels, affording possibilities for coordinated responses that yield high potential for collective human adaptive capacity.

Is a fifth wave emerging?

Four waves of DRS have revealed a complex set of insights and findings about human resilience and the multiple systems and processes that shape resilience in human adaptation and development. However, evidence and theory to date point to higher-order multisystem processes and patterns involved in human capacity to adapt, particularly in situations of cascading multisystem disasters, that to date are not well understood. As efforts to measure and model complexity emerge in the study of human resilience, multisystem threats facing humanity worldwide add a rising sense of urgency to the original and overarching goal of resilience research to improve human adaptation to adversity. The growing focus on multisystem methods and processes in DRS may signal the rise of a fifth wave focused on multisystem integration and the dynamics of system interactions, with the possibility of informing further development of interventions directed at changing the interplay of multiple systems or coordinating multiple targets of intervention for synergy.

Whether this shift in focus to multisystem processes and patterns represents a fifth wave or the maturation of the fourth wave, the following questions will need to be addressed.

- What are the greatest multisystem threats to human development?
- How can schools and communities implement multisystem prevention and intervention strategies to bolster resilience in children, youth, and their families?
- When in development and how do challenges and stress exposure enhance resilience?
- Given the biological wear and tear that can arise within individuals in contexts of structural racism or discrimination, marginalization, and oppression (even among high achieving individuals), how can schools, communities, and/or states confront and dismantle structural and deeply embedded forms of racism, injustice, trauma, or persecution that can pose lifelong threats to healthy development and well-being?
- Relatedly, what interventions work to prevent intergenerational transmission of trauma and promote healthy development in communities affected by historical trauma?

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- What are practical and valid ways to measure and study complex adaptive processes in action and the "roller coaster" pathways of human development in the context of multisystem threats and protective processes?
- Which interventions and targets for change, at which points in development for whom, have the most leverage or potential to trigger developmental cascades that alter development in favorable directions, interrupting negative cascades across systems and levels and/or promoting positive cascades?
- Which malleable targets for intervention show transdiagnostic promotive or protective effects that mitigate or counter threats to development?
- What changes are needed in societies, higher education, and the priorities of funders to prepare a multidisciplinary workforce of researchers, educators, practitioners, inventors, policymakers, and other essential experts in the arts and sciences to meet the challenges posed to human life and development by multisystem disasters, expected and unexpected?
- What are the unique contributions that developmental scientists and science organizations can make to enhancing human capacity for resilience at multiple system levels?

The study of resilience always comes back to these questions: *What makes a difference?* and *What can we do about it?* These simple questions harbor enormous complexity for scientific inquiry about resilience processes, how they work, and how this knowledge can best be harnessed to protect and enhance the healthy development and well-being of people everywhere. There are many difficult questions ahead, as well as challenges inherent in studying the behavior of complex adaptive systems. Yet there has been observable progress. There are consistent findings and intriguing parallels across levels and disciplines, evidence on interventions that work, and a growing body of research as well as a growing cadre of young scholars engaged in research on resilience. There has been a profound shift in the focus of many disciplines concerned with the development and well-being of children, away from models that narrowly focused on vulnerabilities, stressors, risks, symptoms, and strategies for "fixing" problems or treating deficits toward models that include or even emphasize multisystem strengths, resources, promotive and protective influences and positive processes in adjustment, development, and achievements, along with strategies for preventing or mitigating risk and adversity exposure, boosting resources, building protections, and enhancing opportunities.

Families, schools, communities, cultures, and governments all play vital roles in the development of resilience in their children, who in turn protect the future resilience of societies. DRS continues to evolve toward deeper understanding of multisystem and multilevel processes that support and nurture human capacity for surviving, learning, and even flourishing in response to adversity –on small and large scales, spanning challenges from the cellular to global level, and momentary to evolutionary time scales. The progress and evolution in multisystem resilience science and its promise for informing prevention and practice offers hope for future human well-being and development during these exceptionally turbulent times.

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