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Resilience in Development and Psychopathology: Multisystem Perspectives

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systems, cascade, protective, promotive, pathways, transdiagnostic

Abstract

Resilience science in psychology and related fields emerged from clinical research on risk for psychopathology in the 1970s and matured over the ensuing decades with advances in theory, methods, and knowledge. Definitions and models of resilience shifted to reflect the expanding influence of developmental systems theory and the growing need to integrate knowledge about resilience across levels and disciplines to address multisystem threats. Resilience is defined for scalability and integrative purposes as the capacity of a dynamic system to adapt successfully through multisystem processes to challenges that threaten system function, survival, or development. Striking alignment of resilience factors observed in human systems, ranging from individuals to communities, suggests the possibility of networked, multisystem protective factors that work in concert. Evidence suggests that there may be resilience factors that provide transdiagnostic protection against the effects of adverse childhood experiences on risk for psychopathology. Multisystem studies of resilience offer promising directions for future research and its applications to promote mental health and positive development in children and youth at risk for psychopathology.



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INTRODUCTION

Interest in resilience has fluctuated over the past half-century but is now surging across many fields of inquiry, likely for multiple reasons. One reason is widespread alarm about the observable increases in threats from natural and technological disasters, pandemics, terror, and political conflict around the world (Masten 2014a, 2021). These threats are global in reach and multisystem in nature, requiring integrated efforts to prepare and respond effectively with knowledge from multiple disciplines concerned with resilience in systems that influence human life and well-being. A second reason is growing evidence that adverse childhood experiences may have lasting effects on health and development across the life span and even across generations (Bowers & Yehuda 2020, Hughes et al. 2017). A third reason for interest in resilience is attention to transdiagnostic risk for psychopathology, most notably posed by trauma in childhood, and the possibility that there may also be transdiagnostic protections or buffers against such risk (McLaughlin et al. 2020).

Research on risk for psychopathology gave rise to resilience science as investigators studying the etiology of psychopathology recognized unexpected positive variations in adaptive behavior and development among high-risk samples of children (Garmezy 1985, Masten et al. 1990, Rutter 1987). Adverse life experiences in childhood were implicated in the etiology and course of psychopathology early in the history of clinical science (Garmezy & Rutter 1983). In many diathesis–stressor models of psychopathology, adverse experiences exacerbated the effects of biological vulnerabilities for disorders (Rudolph et al. 2015). These models focused typically on pathways toward psychopathology rather than pathways leading to mental health. However, once investigators attended to variability in the life course of children at risk for psychopathology, resilience research emerged from efforts to account for positive patterns as well as negative pathways. As resilience science continued to evolve, advances in knowledge, tools, and methods spurred changes in models, questions, and implications for practice (Masten & Cicchetti 2016).

This review of research on resilience in children and youth highlights changes in resilience science as a dynamic systems perspective took hold and calls increased to integrate models and findings across multiple systems and levels of analysis. We endorse a systems definition of resilience

with the goal of scalable and portable relevance to multiple disciplines and multiple levels of analysis. Subsequently, we discuss implications of a multisystem developmental framework for resilience research and its applications in practice, commenting on emerging directions of research.

DEVELOPMENTAL RESILIENCE SCIENCE AFTER HALF A CENTURY

Resilience research in psychology emerged around 1970 in the same context that gave rise to developmental psychopathology (Masten & Cicchetti 2016). Influential scholars, including Achenbach, Bowlby, Egeland, Garmezy, Gottesman, Rutter, Sameroff, and Sroufe, generated interest in explicating positive as well as negative adaptation, including pathways leading away from psychopathology. Their interactions and collaborations braided developmental, clinical, and genetic perspectives, influencing a generation of scholars in clinical, developmental, community, and prevention sciences.

Four major waves of resilience research ensued (Masten 2007, 2014b; Wright et al. 2013). Wave one was descriptive, as investigators worked to identify attributes that differentiated those who did well versus poorly in the context of various risks. Wave two focused on processes explaining how such attributes resulted in better adaptation. Wave three followed as investigators targeted these processes to foster better adjustment among young people enduring poverty, loss, abuse, mental illness in a parent, and other adversities. Experimental interventions also provided powerful tests of resilience models. Wave four, arising from advances in methodology, developmental theory, and knowledge, was characterized by more dynamic, systems-oriented approaches. This wave generated a focus on interactions of genes with experience and individuals with their contexts, as well as integration of knowledge across disciplines and levels of analysis.

Recent field

4 waves to work on Re

Systems thinking infused developmental theory (Griffiths & Tabery 2013, Lerner 2006, Overton 2013) as well as developmental psychopathology (Cummings & Valentino 2015, Granic & Hollenstein 2003, Hayden & Mash 2014, Masten & Kalstabakken 2018). Although varied in focus, perspectives grounded in developmental systems theory generally emphasize that the current function and future pathways of a system are shaped by reciprocal interactions and coactions across multiple system levels (e.g., genetic, neurobiological, behavioral, environmental), famously illustrated by Gottlieb (2007). Although the shift in resilience models toward a developmental systems perspective was observable more than a decade ago (e.g., Cicchetti & Blender 2006; Masten 2001, 2007; Masten & Coatsworth 1998), integrated multisystem approaches emerged more recently (e.g., Liu et al. 2017, Masten 2016, Panter-Brick & Leckman 2013, Ungar 2018).

multisystems thing

approaches taking the multisystems is recent ~ 10 years

As developmental resilience science shifted toward multisystem models, definitions of resilience also changed. From the outset, definitions varied; some investigators focused on resilience as the capacity to adapt in the context of risk or adversity, while others defined resilience as an outcome or a process (Masten et al. 1990). The idea that resilience is an individual trait has persisted despite decades of arguments and evidence disputing this notion (Kalisch et al. 2019, Masten & Cicchetti 2016). Although definitions of resilience continue to be the subject of ongoing analysis (e.g., Aburn et al. 2016, Kalisch et al. 2019, Liu et al. 2017), there is growing support for a definition of resilience that is scalable across levels of analysis and suitable for communication across disciplines.

Different definitions

RESILIENCE DEFINED FOR MULTISYSTEM SCALABILITY AND INTEGRATION

With a consensus in favor of unifying resilience science, there was a notable change in the definitions of resilience offered by diverse scholars, typically reflecting the idea of complex systems that



Table 1 Sample of resilience definitions reflecting a dynamic systems perspective

Source	Definition
Acosta et al. (2017, p. ii)	"...the capacity of a dynamic system, such as a community, to anticipate and adapt successfully to challenges"
Cicchetti (2013, p. 404)	"...a dynamic developmental process encompassing the attainment of positive adaptation despite exposure to significant threat, severe adversity, or trauma..."
Feder et al. (2019, p. 443)	"...a complex and dynamic process, broadly defined as the ability to adapt successfully to adversity, stressful life events, significant threat, or trauma"
Folke (2016)	"...persistence, adaptability, and transformability of complex adaptive social-ecological systems...having the capacity to persist in the face of change, to continue to develop with ever changing environments"
Luthar et al. (2015, p. 247)	"A dynamic process reflecting positive child adjustment despite significant risk or adversity"
Masten (2007, p. 921)	"...the capacity of dynamic systems to withstand or recover from significant disturbances"
Panter-Brick & Leckman (2013, p. 333)	"...the process of harnessing biological, psychosocial, structural, and cultural resources to sustain well-being"
Ungar (2018)	"...the capacity of a system to anticipate, adapt, and reorganize itself under conditions of adversity in ways that promote and sustain its successful functioning"
van Breda (2018, p. 4)	"The multilevel processes that systems engage in to obtain better-than-expected outcomes in the face or wake of adversity"

are dynamic, adaptive, and evolving. **Table 1** provides a sample of resilience definitions reflecting a dynamic systems perspective. For the purposes of this discussion, we define resilience as the capacity of a dynamic system to adapt successfully through multisystem processes to challenges that threaten the function, survival, or development of the system. This broad definition can be applied to dynamic systems of many kinds and levels, including systems within living individuals (e.g., immune system) as well as whole individuals, families, economies, schools, communities, societies, and ecosystems, spanning research in multiple disciplines.

def of resilience (re)

The rationale for a scalable definition of resilience is compelling, not only to support effective communication among investigators from different disciplines, but also to integrate the science and ideas needed to address multisystem hazards confronting human life and development around the world. Natural disasters and pandemics, for example, pose multisystem threats that cross many boundaries in their impact on human life (Masten & Motti-Stefanidi 2020). Adequate preparation and response to multisystem disasters, expected or unexpected, call for unified approaches informed by multidisciplinary theory and evidence.

From a developmental systems perspective, children's lives are shaped by the interactions and coactions of many systems in concert (Bronfenbrenner & Morris 2006, Gottlieb 2007, Overton 2013). A child continually interacts with numerous systems, initially dominated by caregiving and family processes and later expanding to interactions with other families, schools, friends, teams, and so forth. Each of the proximal systems of a child's life has additional connections with other systems (e.g., parent's workplace, state government) that influence the experience of the child more indirectly. However, children also influence their contextual systems, in turn changing them through their behavior; developmental interactions are transactional and multidirectional in nature. Brain development, for example, is shaped by multilevel processes linking genes with experience, and, reciprocally, maturing brain functions and processes increase adaptive capacity as a result of both neural development and learning. Decisions supported by neurobehavioral functions in turn influence the contexts of development. The resilience of families or communities also changes continually as these systems develop over time and interact with multiple other systems within and between different levels of functioning.

explanation of why we want to use a developmental way of seeing things

The significance of a developmental systems perspective on resilience in children, as well as their families and other life contexts, is multifaceted. Implications of a developmental systems approach to resilience include the following:

- Resilience is dynamic, changing over time as a result of multiple processes and development.
- Resilience of a person or a family extends beyond the individual or family system level to encompass the capacity and resources that can be mobilized in response to challenges through processes connecting that person or family to additional capacity and resources.
- Resilience capacity is distributed across multiple systems; the resilience of an individual person depends on many systems, both internal and external to the person.
- Resilience can manifest in multiple possible pathways over time.
- Resilience can cascade across levels, domains of function, and generations.
- Interventions to nurture or bolster resilience can target different processes within levels or linking system levels.

developmental approach to re

In the next sections, we highlight methods and findings from research on resilience in children and youth. Empirical examples of resilience processes, cascades, and pathways of resilience are included to delineate progress in resilience research from a multisystem, developmental perspective.

MODELS AND METHODS IN DEVELOPMENTAL RESILIENCE RESEARCH

Research on resilience encompasses questions, models, measures, and analytical strategies that have evolved over time. A set of basic questions typically addressed in resilience research focused on children and youth includes the following:

- What are the risks, challenges, or threats to adaptation or development under study?
- What are the criteria for judging how well individuals are doing?
- What factors are associated with doing well (or better than expected) in these circumstances?
- How and when do these factors work? What processes and systems afford resilience?
- How does resilience develop? How is resilience nurtured and promoted (broadly or with respect to specific contexts of risk)?

common questions in re research

These questions set the operational stage to develop models and measures for resilience research.

Two Essential Components for Studies of Resilience

Resilience science focuses on discovering how systems adapt in the context of disturbances that pose significant threats to the systems under study. Investigators noted decades ago that there were two essential components to identify and measure in order to study resilience: (a) risk or threats to the person or system and (b) criteria by which successful adaption or recovery would be evaluated (Garmezy et al. 1984, Luthar 1991).

Risk refers to an elevated probability of an undesirable outcome, and a risk factor indicates elevated risk for a specified negative outcome in members of a group or population (Kraemer et al. 1997, Masten 2014b). In the literature on children, many kinds of risk and adversities have been studied, including maltreatment, poverty, discrimination, natural disasters, bereavement, sectarian violence, war, mental illness in parents, institutional rearing, and foster care. Recent theory delineating the influences of adverse experiences on problems in development includes the role of trauma and chronic stress exposure in transdiagnostic risk for psychopathology (Fritz et al. 2018a, McLaughlin et al. 2020, Shonkoff et al. 2012, Snyder et al. 2017).

def of risk



In early risk studies, investigators noted that risk factors tend to co-occur or pile up in the lives of children or families, concurrently or sequentially—an observation that led researchers to study cumulative risk (Evans et al. 2013, Masten & Cicchetti 2016). Measures of cumulative risk typically assessed negative life experiences utilizing life event questionnaires, structured interviews, or counts of well-known sociodemographic risk factors or some combination of these methods. The Adverse Childhood Experiences measure (ACE; Felitti et al. 1998), initially developed as an adult self-report questionnaire about childhood experiences, became widely utilized for surveillance of risk by state departments of health and the Centers for Disease Control and Prevention (2019). There are now versions of ACE questionnaires for parents to report on their children's lives and youth to report on their own lives.

Cumulative risk measures showed short- and long-term dose effects, where higher scores, indicating more negative life experiences or risk factors, are associated with more problems (Evans et al. 2013). Dose effects have been noted in studies of trauma associated with natural disasters and war (Masten et al. 2015), as well as maltreatment in the family (Cicchetti 2013), and show long-term effects with respect to various measures of adult health and well-being (Hughes et al. 2017). Dose effects based on summing risk factors suggested that there may be common mediating pathways of risk, such as the wear and tear on the body of chronic stress (McEwen 2020); however, there could be many processes converging to interfere with system function in different ways.

Studies of families with a high loading of risk for a specific disorder also show features of dose effects. Risk for developing schizophrenia or bipolar disorder, for example, is higher if both biological parents have a mental disorder than if only one parent does (Gottesman et al. 2010). Similarly, children in families with multiple first-degree relatives with autism spectrum disorder (ASD) have a higher risk of developing this disorder than children in families with an isolated incidence (McDonald et al. 2019).

Cumulative risk scores are powerful predictors, but they also obscure the effects or processes linked to specific kinds of threat. There have been periodic efforts to unpack risk, with mixed success, although findings consistently suggest that exposure to more extreme forms of personal violence in contexts of child abuse, war, or terror are associated with more posttraumatic stress symptoms (Masten & Cicchetti 2016).

The second essential component for studies of resilience is to identify the criteria for judging adaptive function or development in relation to various risks. Resilience is not simply the study of doing well in life, which one could describe in terms of competence, health, or positive development (Masten & Coatsworth 1998). Human resilience science focuses on understanding variation among populations of people exposed to well-established risk factors, adversities, and other conditions known to forecast problems in health, well-being, or development: It is the study of individuals “off the risk gradient” who manifest positive adjustment and development despite risk or adversity exposures. Again, many criteria for judging “good adaptation” have been studied, including age-salient developmental tasks, physical health, subjective well-being, and normative or lower-than-expected rates of symptoms associated with specific risk factors or level of risk (Masten 2014b).

Developmental task criteria became a popular way to judge adaptive function in longitudinal studies following cohorts of children at risk over time (Masten & Tellegen 2012, Sroufe et al. 2005, Werner & Smith 1982). Developmental tasks include multiple dimensions of age-graded adjustment or competence that signify development is proceeding well on the basis of normative expectations for development in a given historical time and cultural context (Masten & Coatsworth 1998). Success in such tasks forecasts competence in later tasks. While some tasks are common across cultures, such as forming a close bond with caregivers, learning to walk and talk, complying

with family and community norms, and getting along with other people, other tasks are more culturally or contextually specific, such as undergoing religious rites of passage or learning to hunt or weave in traditional ways (Wright et al. 2013).

Studies of traumatic life experiences and familial risk for psychopathology tend to focus on negative adaptive criteria such as (lower) levels of traumatic stress symptoms or disorder. Studies of familial risk—where considerable genetic risk is indicated for a particular psychopathology spectrum of disorder—often begin by focusing on children who escape dysfunction or disorder; this was the case in classic risk studies of psychiatric disorders (e.g., schizophrenia) that gave rise to interest in resilience in clinical research (Garmezy 1985). In contrast, most contemporary resilience studies include positive criteria of adjustment or development, whether they are studies of adaptation in the context of adverse experiences or studies of children at risk for disorders, rather than focusing solely on negative criteria such as “trauma symptoms” or “not developing symptoms of a disorder.” Current studies of infants at risk because they are biological siblings of children diagnosed with ASD have begun to consider resilience models to understand why some siblings develop ASD or other problems while other siblings show more neurotypical or adaptive development (Elsabbagh 2020, Lai & Szatmari 2019). In addition to charting markers of risk in order to predict future diagnoses and symptomology, investigators are interested in discovering how adaptive systems operate in the first few years of life to shift developmental pathways toward and away from ASD-related disability so as to better understand heterogeneity and related processes.

Resilience Factors and Processes: Promotive and Protective Effects

Early stages of resilience research in various domains of risk often began with efforts to identify the correlates or predictors of better adaptation (by the chosen criteria) in the context of risk or cumulative risk. In theory and empirical studies, promotive effects were distinguished from protective effects by the nature of their predictive effects on the adaptive criteria in relation to risk. Promotive effects refer to predictors of better adjustment regardless of risk level, akin to a main effect in statistical models. Protective effects have variable effects depending on the level of risk, with greater influence at higher levels of risk or adversity, akin to an interaction effect in statistical models; the form of such interactions is consistent with a buffering effect on the criterion of adjustment when the dose/risk level is high. Moderator effects are challenging to interpret because many moderators are assessed on a continuum (e.g., parenting quality) where the negative end of the moderator could be construed as a vulnerability, exacerbating the effects of risk. Moreover, interaction effects in variable-focused studies could represent different processes for different individuals. The protective effects of a moderator variable for individuals high on that variable could be operating through different processes from the negative effects of the same variable at the other end of a dimension.

Note that while scholars often use the term protective factor in the context of their studies, they are actually referring to protective effects (functions) of a variable with respect to a particular risk context and criterion of adaptation. These effects can vary: Rutter (1987) noted decades ago that the same attribute could show a protective effect in one context and a vulnerability effect in another. Nonetheless, it was also evident that some attributes, such as sensitive caregiving, social support, and self-regulation skills, showed consistent associations with better adaptation across multiple criteria of adjustment and diverse conditions of risk.

Investigators soon realized that it was important to include low-risk individuals in their studies in order to distinguish protective from promotive effects. If a study comprises only individuals with high risk levels (such as families living with poverty or homelessness or infants at high familial risk

def of protective vs promotive effects

promotive : regardless of risk

protective : variable effects depending on risk

attributes can be protective or promotive or even a vulnerability depending on the context

ex ?

Important to have people at low risk too, to differentiate promotive from protective.

for developing ASD), then a predictor of better function could represent either a promotive or a protective effect.

Similarly, it can be challenging to distinguish a promotive effect from a risk effect when the promotive variable (e.g., consistent discipline or residential stability) reflects a dimensional variable that has a “low” or disadvantaged end (e.g., inconsistent parenting or residential instability) that could be interpreted as another risk variable. Early reviews of resilience noted the challenge posed by unrefined risk indicators (Masten et al. 1990, Rutter 1987). Refining the risk posed by a parent with schizophrenia has proven to be a decades-long quest, still ongoing (Lenzenweger 2018). Contemporary research on the etiology of ASD poses a similar issue of broad, poorly understood risk indicators (e.g., sibling of a child diagnosed with ASD) and indeterminate genetic liability (e.g., Grove et al. 2019, Ozonoff et al. 2011, Satterstrom et al. 2020). Nonetheless, the study of positive variations in at-risk populations may provide clues to refining risk parameters as well as to identifying protective processes in the search to understand etiological heterogeneity.

With consistent evidence of variables associated with positive adjustment under various conditions of well-established risk, researchers focused on understanding protective processes, often with the goal of informing or improving interventions to promote resilience. Some of these variables were malleable (e.g., parenting) and thus could be the target of change in interventions, while others were static (e.g., sex) but could improve tailoring of interventions or uncover new, potentially malleable processes.

Measures of promotive and protective variables for children and youth in the early research on resilience focused on attributes of the family and child suggested by case studies and findings from early empirical studies (Garnezy 1985, Masten et al. 1990, Rutter 1987). These included family attributes (e.g., good-quality parenting, warm relationships, family cohesion), child attributes (e.g., cognitive skills, optimism, self-efficacy), and external support outside the family (e.g., friends, religious affiliations, effective schools and teachers). The variety of measures and constructs included in early research, however, posed considerable difficulties for systematic reviews of the literature.

Over time, investigators developed multidimensional scales to measure resilience, usually referring to variables consistently associated with resilience in the context of diverse kinds of risk and adversity. Some of these measures focus on individual attributes, while others also include protective factors in the family or community. Most are questionnaires for self-report by older youth and parent or teacher reports about children or youth. In a systematic review of resilience measures, Windle (2011) found few measures for children and adolescents that met quality standards for inclusion.

At present, one of the most widely used questionnaires internationally is the Child and Youth Resilience Measure (CYRM) developed by Ungar and collaborators (Renbarger et al. 2020, Ungar & Liebenberg 2011). The CYRM was carefully developed for multicultural use with input from many investigators and pilot testing with diverse youth from multiple cultures. Core items from the short form (Liebenberg et al. 2013) include “I have people I look up to,” “I feel I belong at my school,” “I am treated fairly by my community,” and “I enjoy my cultural and family traditions.” These items illustrate the effort to assess sources of resilience at the levels of family, school, and community, as well as the individual.

Another type of emerging resilience measure is focused on positive life experiences that may counteract the negative effects of adverse childhood experiences. Hays-Grudo & Morris (2020) developed the PACE (Protective and Compensatory Experiences questionnaire) as a counterpoint to the ACE. Narayan et al. (2018) developed the 10-item Benevolent Childhood Experiences (BCEs) scale with similar goals in mind (Narayan et al. 2020). Example items from the BCEs include the following: “Did you have at least one caregiver with whom you felt safe?” and “Did you have at least one teacher who cared about you?”

Models Linking Risk, Adjustment Criteria, and Adaptive Processes

Studies of resilience include person-focused and variable-focused models and methods, as well as mixed methods (Luthar 2006, Masten 2001). **Person-focused studies**, characterized by the study of individuals who manifest resilience in their lives, have a number of strengths, including their compelling testimony to phenomena of resilience, capturing the person as a whole (which is consistent with a systems perspective), and providing clues to resilience that can be studied further in more representative and diverse samples. **Variable-focused studies** are superior for testing specific ideas about the relations among parameters linking risk and adaptation to factors and processes that mitigate, counter, or buffer against the consequences of high exposure to risk or adversity for young people. **Newer methods of analysis** also provide strategies for combining the strengths of person-focused and variable-focused methods.

-Person-focus > capture the person as a whole
-variable-focus > testing specific ideas about relations and parameters linking risk and adaptation to factors and processes.
-new methods > strategies to combine both

Resilience research often was inspired by case studies, the most fundamental person-oriented strategy for studying psychosocial behavior at the individual level. Pioneers in the field, such as Garmezy (1985), described individual cases in their publications and presentations about resilience. Compilations of case studies also are notable in the resilience literature. One such compilation, *Out of the Woods: Tales of Resilient Teens* (Hauser et al. 2006), drew on data from a unique clinical study of youth hospitalized as adolescents for serious mental health problems to provide intensive case narrative accounts of four young people who manifested resilience over the 12 years of the study. These cases implicated familiar protective factors, including positive relationships, agency, optimism, and a search for meaning. Biographies and autobiographies in books and films continue to provide many examples of resilience in the lives of young people, including Malala Yousafzai, who survived an assassination attempt by the Taliban and received a Nobel Peace Prize for championing the right of girls to education.

Pathway models of resilience represent quintessential person-focused models of development delineating major patterns of response or development observed or expected in relation to acute or chronic adversity. Pathway models have deep roots in developmental systems theory as well as in developmental psychopathology (Masten & Cicchetti 2016). Numerous examples of pathways illustrating resilience in the context of acute and chronic adversity can be found in the literature (e.g., Ioannidis et al. 2020, Masten & Narayan 2012, Masten & Obradović 2008). **Three major patterns of adjustment to adversity identified in the resilience literature are stress resistance, breakdown with recovery, and posttraumatic growth** (Masten & Cicchetti 2016). Models of this kind are indebted to the pathway models that Gottesman (1974) developed in his diathesis–stress model of schizophrenia.

Pathway models

Pathway models were initially based on observed variations in the course of individual behavior and development over time. Studies of pathways toward and away from psychopathology have played a central role in developmental psychopathology (Cicchetti & Rogosch 1996, Masten & Kalstabakken 2018). Turning points and branching pathways held particular interest for research on resilience because they suggested where and when to look for clues to positive change or divergence throughout development.

With the advent of statistical methods for the study of developmental growth patterns and trajectories in longitudinal data, it became **more feasible for investigators to test pathway models empirically** (e.g., utilizing **latent class analysis or growth mixture modeling**; Jung & Wickrama 2008). Growth mixture modeling integrates person-centered methods with **variable-centered analyses to explicitly model unobserved heterogeneity** (latent classes) in a given population, a strategy well suited to the investigation of developmental pathways (Muthén & Muthén 2000). For example, general growth mixture models can estimate growth curves for unknown latent classes, quantitative variation within classes, predictors of latent class membership, and the extent to which **class membership is associated with future outcomes of interest** (Muthén & Muthén 2000).

Usage of LCA and GMM with development of statistical methods to study pathways

mix of person centered and variable centered



There is a growing body of research on resilience utilizing these strategies, including studies of pathways of posttraumatic stress following disasters (e.g., La Greca et al. 2013, Osofsky et al. 2015) and war trauma (e.g., Betancourt et al. 2013), as well as the context of child maltreatment (Miller-Graff & Howell 2015). In these studies, trajectory analyses of symptoms among traumatized children all found one or more resilient trajectories, including a pattern of improving (falling) symptoms over time within a group of individuals as well as a group that showed consistently low symptoms, congruent with the theoretical resistance pathway. Similarly, studies of infants at heightened familial risk for ASD and low-risk controls consistently report subgroups with increasing trajectories of cognitive functioning in specific domains or overall adaptive behavior that include both high- and low-risk infants (Bussu et al. 2019, Franchini et al. 2018, Sacrey et al. 2019).

It is also feasible to model trajectories of adaptive responses to adversity at the level of families, schools, or communities, although empirical studies of such trajectories are rare. Lai et al. (2019) studied trajectories of academic recovery in schools after Hurricane Ike in Texas. They identified two trajectories based on growth mixture modeling of administrative data on test scores, attendance, and student demographic data aggregated at the school level: 90.5% of schools showed a stable high-functioning trajectory and 9.5% showed a low-interrupted pattern suggesting disrupted function with recovery under way.

Variable-focused models and methods are characterized by positing and testing ideas about the interconnections among the variables indexing risk, adaptive function, and purported promotive or protective factors that may account for resilience (Masten 2001). **Figure 1 illustrates several classical models commonly tested in studies of resilience.** Examples include a cumulative risk model; a nonlinear challenge model where optimal adaptation falls in the middle range of adversity exposure, consistent with stress inoculation or steeling effects (Rutter 1987); and two classical models involving resilience factors. One is a main effects model with a risk and a promotive factor, and the other is an interaction model with a protective moderating effect in addition to a main effect of a resilience variable.

Figure 2 illustrates a more complex model that includes time and cascading effects, where effects of risk and resilience factors have spreading influence over time through multiple pathways of interaction (Masten & Cicchetti 2010). In this example of the many different effects that could be modeled, we show a model with a risk factor at Time 1 having transdiagnostic effects over time through multiple pathways, one of which includes a mediator. For example, if the risk factor was a cumulative risk indicator, the mediator could be executive function (EF), reflecting harmful effects of adversity in early childhood on the neurocognitive development of EF (Zelazo 2020). Harm to EF, in turn, may lead to more transdiagnostic symptoms as well as lower adaptive functioning (e.g., school readiness), potentially jeopardizing a key developmental task. A resilience factor is also included with both promotive and protective effects, countering the risk posed by the risk factor to the mediator as well as influencing symptoms and adaptive behavior. **Effective caregiving or parenting often demonstrates both promotive and protective influences on multiple domains of adaptive and maladaptive child functioning, including EF skills** (Masten & Kalstabakken 2018). Early buffering by effective parenting may limit the harm posed by early adversity, interrupting negative cascades and promoting positive ones.

In a different example, postpartum depression in the mother could serve as the risk factor in **Figure 2**, and the mediator could be parenting (Goodman & Garber 2017). In this case, the resilience factor might be a multimodal intervention that combines treatments for maternal depression (to mitigate risks posed by a depressed parent on parenting and thereby child development) with treatments to directly provide more stimulation and consistent care for the child. Doty et al. (2017) have proposed a cascading resilience model of this kind to explain how interventions

a variable can be both protective and promotive

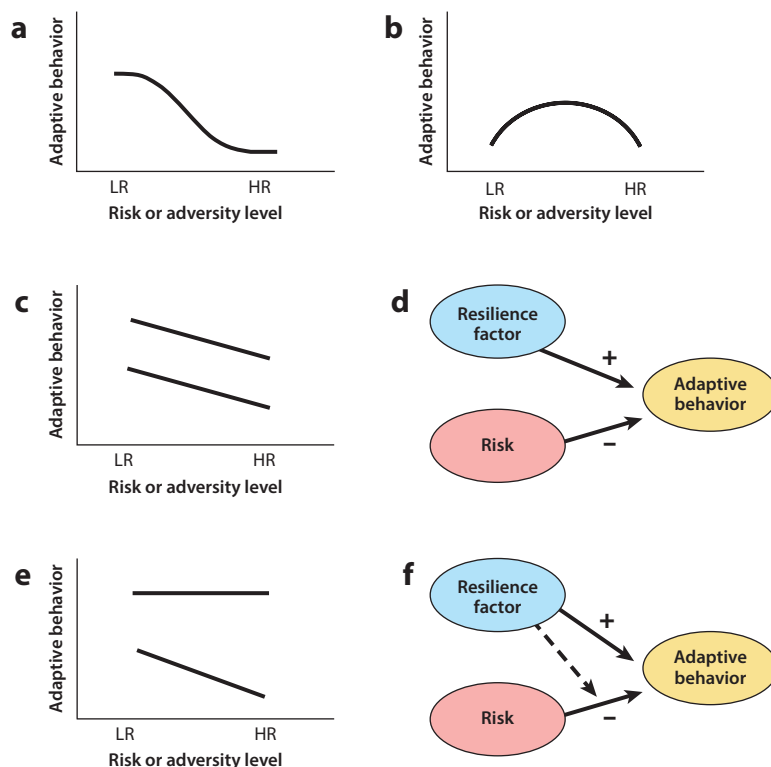


Figure 1

Examples of widely used models linking risk or adversity to adaptive behavior. (a) Cumulative risk model. (b) Challenge model showing better adaptive behavior with some, but not too much, exposure to adversity. (c) Main effects model showing a dose effect of risk or adversity in combination with a direct effect of a promotive resilience factor. (d) A path model version of model c. (e) Moderator model consistent with a resilience factor having both promotive (compensatory) and protective (buffering) effects in the context of risk. (f) A path model version of model e. Abbreviations: HR, high risk; LR, low risk. Panels a, b, c, and e adapted from Masten et al. (1988, figure 1). Panels d and f adapted from Masten (2001, figures 1 and 3).

focused on parenting can have multilevel, spreading effects over time. Two-generation interventions to foster resilience with multiple targets for change are also becoming more prevalent in clinical and humanitarian interventions (Masten 2018).

Cascade models control for concurrent covariation as well as continuity within domain in order to test for cascading effects. Cascade effects may account for some of the transdiagnostic influences attributed to risk factors (e.g., child maltreatment) and protective factors (e.g., good parenting or social support; McLaughlin et al. 2020).

Still missing in cascade models, however, is the dynamic interplay of complex adaptive systems. New methods for modeling interactions and change over time have begun to address this gap in research on resilience through longitudinal modeling of change and interactions between people and variables. In a study of parenting as a protective influence on the behavior of young children experiencing homelessness, Herbers et al. (2014) utilized microsocial coding of video recordings of structured parent–child interaction and state-space grid analysis to demonstrate that positive coregulation by parents in dyadic interactions was related to child EF, IQ, and subsequent success at school.

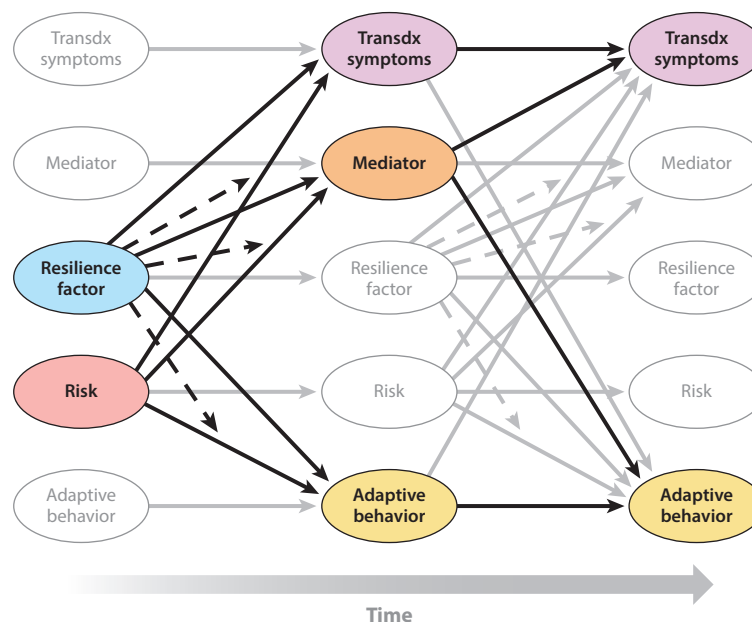


Figure 2

Example model of risk and resilience factors with cascading, transdiagnostic effects on psychopathology and adaptive behavior through multiple paths of influence. Three time points are shown. This model includes a mediator of risk that is also influenced by a resilience factor. Moderating effects of the resilience factor are shown for the effects of Time 1 risk on symptoms, the mediator, and adaptive behavior at Time 2, mitigating the effects of Time 1 risk on these aspects of functioning. Also shown are direct promotive effects of the resilience factor on symptoms (predicting fewer symptoms), the mediator (improving its function), and adaptive behavior (predicting more adaptive behavior). These effects, in turn, influence symptoms and adaptive outcomes at Time 3. Continuity over time within each of the five variables is indicated in light gray, along with other possible effects, such as ongoing promotive and protective effects of the resilience factor between Time 2 and Time 3. Not shown are arrows indicating covariation within time among all five variables and other possible effects. Dashed arrows represent moderating effects of the resilience factor on risk effects (interactions of the resilience factor with risk).

Recent research on bodily movements in ASD illustrates an innovative nonlinear dynamics method, called cross-wavelet analysis (Romero et al. 2018). Investigators measured time-dependent, coordinated whole-body movement in children as they interacted with a clinician. Children with ASD coordinated their movements in complex ways that matched the movements of the clinician, and these movement patterns were related to social cognitive ability. Another study utilized wavelet transform coherence and found that increased neural synchrony between mothers and their preschoolers with ASD solving a Tangram puzzle together was associated with higher behavioral reciprocity and problem-solving success (Nguyen et al. 2020).

One of the most interesting new approaches for modeling resilience to accommodate dynamic interactions has been suggested by Kalisch et al. (2019) in a paper aptly titled “Deconstructing and Reconstructing Resilience: A Dynamic Network Approach.” They extend the strategy of network modeling of mental disorders to encompass the effects of resilience factors (e.g., emotion regulation) within broader networks of interconnected symptoms. On the basis of this model, mental disorders are constructed as a network of symptoms, and protective factors operate through their capacity to weaken the interconnectedness of symptoms. Theoretically, protective factors help transition a network toward lower activation of symptoms to support a state of mental health. In

Table 2 Short list of multisystem resilience factors

Sensitive caregiving, close relationships, social support
Sense of belonging, cohesion
Self-regulation, family management, group or organization leadership
Agency, beliefs in system efficacy, active coping
Problem-solving and planning
Hope, optimism, confidence in a better future
Mastery motivation, motivation to adapt
Purpose and a sense of meaning
Positive views of self, family, or group
Positive habits, routines, rituals, traditions, celebrations

The short list of resilience factors

this model, protective factors can be activated by a stressor and can be dynamic, waxing and waning in their capacity to influence the symptom network or effects of stressors. Resilience factors can avert the cascading effects of a stressor that could potentially send a network of symptoms toward a state of disorder (e.g., anxiety). Resilience processes in this model encompass multiple resilience factors and their interactions with time-varying symptom networks.

The hybrid symptoms-and-resilience-factor networks described by Kalisch et al. (2019) can theoretically be modeled using mathematical strategies developed to study complex system dynamics. Fritz et al. (2018b) have also proposed a network model of resilience factors in adolescents and other strategies for modeling dynamic systems in resilience. Ioannidis et al. (2020) presented a trajectory model of resilience in a complex system utilizing simulated data. These new approaches offer promising directions for future research on resilience in complex adaptive systems, although acquiring the data required to test these models is a daunting challenge.

New directions for research :
complex system dynamics, networks models

CONVERGING EMPIRICAL EVIDENCE ON MULTISYSTEM RESILIENCE

Narrative reviews of research on resilience in children and youth over the years, drawing on evidence from studies of varying risks and adaptive criteria from different countries, have often identified a set of familiar attributes of children and their contexts associated with resilience (Masten 2001, 2014b; Ungar & Theron 2020). These parameters, familiar as broad correlates of adjustment and psychopathology, constitute “the short list” (Masten 2001, 2014b). The short list may reflect fundamental adaptive systems that evolved over time and generations through biological and cultural processes that afforded biological and sociocultural survival value, gradually enhancing human capacity for resilience (Masten 2001). A growing number of systematic reviews have corroborated the salience of common protective factors (e.g., Fritz et al. 2018a, Gartland et al. 2019, Meng et al. 2018, Yule et al. 2019).

The attributes/variables/parameters of resilience probably reflect fundamental adaptive systems that evolved through biological and cultural processes enhancing human capacity for resilience.

More recently, scholars have suggested that the short list of resilience factors extends across multisystem levels (Masten 2018, Masten & Motti-Stefanidi 2020). This suggestion stemmed from the observation of parallel resilience factors—at both the individual child and family levels—gleaned from relatively independent literatures on resilience (Masten 2018). However, similar alignment can be observed in systems beyond individuals and families, including schools, communities, and cultural systems (Crawford et al. 2006, Fritz et al. 2018a, Masten & Motti-Stefanidi 2020).

Table 2 proposes an integrated multisystem short list of resilience factors reported in resilience studies at the individual, family, school, community, and organizational levels. It is intriguing to

consider the possibility that these attributes associated with resilience in the socioecological systems of human life and development align so well because they engage the same basic adaptive systems at multiple levels of organization. The multisystem short list may reflect the operation of coacting adaptive networks or complex and interrelated systems of resilience that coevolved. Given this possibility, it is not surprising that some of these adaptive systems, such as attachment and social buffering of stress, were preserved across species, particularly mammals (Hostinar et al. 2014).

Cultural Processes in Resilience

Although not explicitly mentioned in **Table 2**, culture infuses every aspect of human resilience, ranging from the adaptive criteria valued within different cultures to the socialization practices of caregivers and teachers (Masten 2014b, Panter-Brick 2015). Culture influences all factors associated with resilience in this multisystem short list. “Every cultural community provides developmental pathways for children within some ecological-cultural (ecocultural) context,” as Weisner (2002, p. 275) noted. Anthropologists study daily activities and routines in part because they reveal cultural values and processes. Cultural narratives expressed in stories, myths, and sacred teachings transmit cumulative wisdom about resilience. Scholars have repeatedly observed the importance of cultural narratives for mental health and resilience among indigenous and ethnic/racial minority populations (Kirmayer et al. 2011, Ungar & Theron 2020).

Early resilience reviews noted the neglect of culture in research on resilience (e.g., Luthar 2006, Spencer et al. 2006). Over the past decade, however, there has been progress in expanding the study of resilience across the Global South and engaging more scholars from multiple cultures in research (Masten & Cicchetti 2016, Theron et al. 2015, Ungar & Theron 2020). The Resilience Research Centre in Halifax, Canada, has played a key role in encouraging multicultural research on resilience by funding international studies, training international young scholars, developing measures for research across cultures, and hosting a series of international conferences on resilience, most recently (2017) in Cape Town, South Africa.

Research on resilience across cultures suggests that resilience factors congruent with the short list often emerge but in culturally distinct forms (Theron et al. 2015). For example, Ungar (2015) described how cultural adherence to beliefs and norms, described as a protective factor in multiple cultures, referred to nationalism in a Russian sample but indicated engagement with the cultural practices of elders in a northern Aboriginal sample of youth in Canada.

The emerging body of multicultural resilience research also suggests that there are unique protective processes, practices, and intergenerational traditions that have enriched the study of resilience in multiple disciplines and opened new lines of inquiry for future studies (Panter-Brick & Leckman 2013, Ungar 2015). Studies of resilience in Africa, for example, have underscored the unique importance of a collective worldview in many African cultures that values interconnectedness and the related philosophy of *ubuntu*, while also noting familiar resilience factors such as close relationships, meaning making, self-regulation, and problem-solving (Theron & Phasha 2015).

Research has expanded over the past decade on resilience among children and youth confronted with the challenges of structural racism or discrimination and marginalization on the basis of cultural or ethnic/racial heritage. Examples include studies of resilience in young people at risk for wide-ranging health, adjustment, and well-being problems related to racism or marginalization of youth native to a country, young refugees fleeing conflict, and immigrants migrating from one region to another (Cabrera & Leyendecker 2017, Horn et al. 2016, Marks et al. 2020, Masten et al. 2019, Suárez-Orozco et al. 2018). One would expect these challenges to reveal unique as well as common resilience factors and they do, reflecting the complexities of these adverse life experiences.

Racism and oppression pose many risks to development at multiple system levels (Benner et al. 2018, Comas-Díaz et al. 2019, Marks et al. 2020, Priest et al. 2013, van Breda & Theron 2018). Growing evidence suggests that positive ethnic/racial identity and racial socialization by parents and families play uniquely important promotive and/or protective roles in the development of young people exposed to structural racism and discrimination (Anderson & Stevenson 2019, Huguley et al. 2019, Marks et al. 2020, Neblett et al. 2016, Rivas-Drake et al. 2014, Umaña-Taylor et al. 2014). Parents prepare their children for the hazards of systemic racism and discrimination in order to protect them from racial harassment and potentially stressful or dangerous racial encounters. Children exposed to positive aspects of their history and heritage through cultural socialization are more likely to develop a positive ethnic/racial identity, an important buffer against racism (Hughes et al. 2006). A new theory called RECAST (Racial Encounter Coping Appraisal and Socialization Theory; Anderson & Stevenson 2019) proposes that racial socialization buffers youth against racial stress and trauma, yielding greater self-efficacy along with racial coping skills that, in turn, facilitate adaptive function in multiple domains.

One of the most important issues raised in recent studies of resilience among ethnic/racial minority or marginalized youth is the possibility of an internal cost for external success, in the form of allostatic load and epigenetic aging (Brody et al. 2020). This phenomenon, sometimes called John Henryism (James 1994), has been observed in a subgroup of resilient African American youth studied by Brody et al. (2020). These authors found that some successful young people showed signs of allostatic load and epigenetic aging indicative of deteriorating health. Dismantling systemic racism is essential for addressing this hidden threat; until then, it will be important to understand how to protect biological as well as psychosocial health against racism and its effects. Another example of a potential internal cost for external success was revealed in research on compensatory strategies for social interaction in ASD. Livingston et al. (2019), for example, found that use of compensatory strategies often was associated with worse health and well-being, including increased stress, anxiety, and depression.

Moving into a new cultural context poses different challenges to refugee and immigrant-origin youth, although immigrant children and youth also frequently face discrimination based on ethnic/racial heritage (Motti-Stefanidi 2019, Suárez-Orozco et al. 2018). In addition to developmental tasks confronting all children in their new societies, immigrant youth face challenges of acculturation along with stressors related to discrimination and poverty that often accompany immigrant status. One of the pioneers in research on intercultural contact and change recently defined acculturation as the “process of group and individual changes in culture and behavior that result from intercultural contact” (Berry 2019, abstract). For youth migrating to a new cultural context, there can be considerable acculturative stress resulting from conflicts between the values, expectations, or practices of their culture of origin and those of the receiving culture, or from becoming a marginalized minority (Dawson & Panchanadeswaran 2010).

In recent years, scholarship on immigrant youth adaptation has undergone a shift in perspective from deficit-focused models to strength-oriented models, observable in special issues of key journals (e.g., Motti-Stefanidi & García Coll 2018) as well as in conferences and books (e.g., Masten et al. 2012). Investigators have observed resilience factors at multiple system levels. At the societal level, examples include supports available for immigrant youth and families and societal valuing of cultural diversity. In more proximal contexts, such as schools or local communities, resilience factors include supports for educating immigrant youth and facilitating positive attitudes toward migrants. At the family level, scholars identify how well the family is functioning economically and helping their children maintain a sense of belonging to their culture of origin. Resilience factors identified at the individual level include positive identity, supportive relationships with peers

Ex : Racism is a risk to development at multiple system levels but growing in an environment that gives you a positive ethnic/racial identity + racial socialization is a promotive/protective factor and help someone might be exposed to racism

Bad physical health to counter balance positive mental health however.

Solutions for resilience (in the context of refugee / migrations) :
support for immigrant
societal valuing of cultural diversity
positive attitudes toward migrants
maintain a sense of belonging to the culture of origin

and teachers, and language facility in the language of the receiving community. Youth who are comfortable navigating their “multiple worlds” (Phelan et al. 1991) fare better.

Neurobiological Processes in Resilience

The adaptive systems and processes listed in **Table 2** also depend on many processes internal to the individuals who are part of these multilevel systems, including many neurocognitive and biological processes that support learning and problem-solving, stress and emotion regulation, cognitive self-regulation, motivation to adapt, relationships, and social interaction skills. Over the past two decades, there has been an explosion of research on the neurobiological processes involved in resilience (Chen 2020, Cicchetti 2010, Feder et al. 2019, Masten & Cicchetti 2016, McEwen 2019). In their recent review of this literature, Feder et al. (2019, p. 443) observed the following: “It is becoming clear that resilience involves active and unique biological processes that buffer the organism against the impact of stress, not simply involve a reversal of pathological mechanisms.” Issler et al. (2020, p. 209) concur, noting that “the molecular basis of resilience is not merely the absence of susceptibility, but rather an active process, with transcriptional and epigenetic mechanisms demonstrated to play important roles.”

Pathways by which adversity “gets into the brain and body” have been the focus of intense research in studies of stress processes and allostatic load, the cumulative wear and tear on the body related to sustained stress (McEwen 2019). However, positive experiences also influence the biology and development of adaptation at multiple neurobiological levels. Evidence supports the protective effects against allostatic load of sensitive caregiving earlier in life and social support of family and friends, as well as having a sense of meaning and purpose later in development (McEwen 2019, 2020). McEwen (2019) viewed the neuroplasticity of the developing brain as central to resilience, asserting that resilience to stress is a key element of a healthy brain.

In research on specific disorders, such as ASD, there are also ongoing efforts to study biological processes that may counter the developmental impact of biological liability for a disorder at different time points in development. Adaptive biological systems may be activated in ways that counteract cascading negative effects or promote positive cascading effects in development. These adaptive reactions could occur even though biomarkers or core endophenotypic expressions of liabilities characterizing the disorder do not change. For example, Johnson et al. (2015) offered a framework for considering neural systems of resilience through which processes of whole-brain ontogenetic adaptation during sensitive periods produce alternative developmental pathways, protecting against early neurobiological risk for ASD and other developmental disorders.

While there is clear evidence of progress in research on the neurobiological processes involved in resilience (Chen 2020, Feder et al. 2019, Murrough & Russo 2019), this body of research is relatively immature compared with research on psychosocial processes. The primary reason is that the tools and techniques that made it feasible to study many of these processes, particularly in children, developed more recently; these include brain imaging, genome-wide genetic studies, epigenomic studies, and various noninvasive methods for assessing biological processes.

The most advanced area of research on the neurobiology of resilience in children may be the study of processes related to the biology of stress and self-regulation. For example, there is compelling evidence for social buffering of the hypothalamic–adrenal–pituitary (HPA) system in humans and animals (Hostinar et al. 2014). Caregivers and peers can moderate stress reactions at the level of epigenetic change as well as behavior (McEwen 2020). Growing evidence also documents the potential role of heart rate variability, a measure of autonomic nervous system activity, as an index of resilience related to emotion regulation capacity (Perna et al. 2020, Saetren et al. 2019). Findings suggest that exposure to manageable doses of stress (both naturally occurring and

through interventions intended as stress inoculation) has positive influences on the capacity to regulate stress reactions at multiple levels of analysis (e.g., HPA processes and emotion regulation; Feder et al. 2019). Increasing evidence is delineating the neurocognitive processes involved in EF, the effects of early adversity on EF development, the transdiagnostic role of EF problems in psychopathology, and the malleability of EF to interventions (Zelazo 2020).

One of the most intriguing new lines of investigation in the biobehavioral study of resilience centers on the possibility of “undoing” or “reprogramming” systems affected by adversity and stress, either during the course of development or in regard to intergenerational transmission of programming effects through epigenetic processes. Recent studies of children affected by institutional rearing suggest that adolescence may be a period of recalibration for stress systems (Gunnar et al. 2020). Another line of research has shown that while trauma effects can be transmitted across generations, protective effects could be transmitted as well, or experiences after birth could undo epigenetic changes to protect the offspring (Bowers & Yehuda 2020). More generally, trauma during sensitive periods in development (with high plasticity) can also cause lasting epigenetic changes that pose problems to later health. McEwen (2019) and others have speculated about possibilities for reprogramming later in development by opening windows of plasticity.

IMPLICATIONS OF MULTISYSTEM DEVELOPMENTAL PERSPECTIVES ON RESILIENCE FOR PRACTICE

The clinical scientists who initiated the study of resilience had the goal of improving interventions for people who were at risk for psychopathology and other problems. As knowledge accumulated on what makes a difference for better functioning or development among young people at risk for various reasons, intervention studies began to apply the evidence in practice and thereby test causal models of resilience (Luthar & Cicchetti 2000, Masten 2011). Most fundamentally, however, resilience science spurred a profound shift away from deficit-oriented intervention models toward strength-oriented models in multiple fields of practice, including clinical psychology and psychiatry, social work, school counseling and special education, child welfare, nursing, and humanitarian aid (Masten 2014b, Panter-Brick & Leckman 2013). Risk remained important, but the conceptual framework for intervention changed to emphasize and include positive goals, assess positive aspects of children and their contexts, consider assets and protective processes as well as risks and vulnerabilities, and include positive indicators of adaptive success and development as well as symptoms or problems (Masten 2011).

Strategies of intervention based on resilience included explicit efforts to prevent or mitigate risk, boost availability of promotive assets and resources, and mobilize or increase adaptive capacity available through adaptive systems, particularly those widely implicated in research (Masten 2011). Notably, resilience-focused interventions do not neglect the vital importance of addressing structural injustice and eliminating preventable risks, including premature birth and exposure to violence. Preventing exposure to toxic experiences is a key strategy for promoting resilience in children.

Integrating the intervention data on resilience poses some of the same challenges as the efforts to review the basic science with diverse samples, methods, and measures. Nonetheless, the evidence based on intervention studies is growing, including the number of completed and in-progress systematic reviews focused on resilience processes such as those listed in **Table 2** (e.g., Barry et al. 2013, Dray et al. 2017, Sandler et al. 2011, Twum-Antwi et al. 2020). These reviews provide evidence that interventions focused on resilience processes show success, although sometimes mixed, at improving mental health and adaptive success of children and youth in the context of adversity or trauma.



Evidence suggests that interventions focused on improving parenting and the quality of early parent–child interactions, in the context of therapy or home visiting by nurses, for example, are particularly effective across wide-ranging situations of adversity, although the processes by which the interventions work are not always well understood (e.g., Leijten et al. 2017, Sandler et al. 2011). In a recent umbrella review of systematic reviews in the maltreatment literature, van IJzendoorn et al. (2019) concluded that interventions typically find modest success and are in surprisingly short supply given the enormous prevalence, human costs, and economic costs of maltreatment in societies around the world.

Research is expanding rapidly on interventions targeting EF skills, particularly in young children, during a window of developmental plasticity in the neurocognitive systems supporting EF development (Zelazo 2020). These self-regulation skills appear to be malleable and related to better school success among diverse samples of children, including children from situations of poverty and family homelessness that jeopardize achievement and mental health. While it is not yet clear whether EF skills play a protective as well as a promotive role for children experiencing adversity, these skills appear to be a malleable mediator of adverse childhood experiences that is responsive to interventions. Malleable mediators of adversity associated with resilience hold keen interest for prevention scientists studying resilience.

Among children already manifesting psychopathology or early symptoms of problems, investigators can aim to avert negative cascades as well as promote competencies. These approaches could lead to less restrictive environments and greater successes in school or the workplace, fostering happiness as well as opening more opportunity pathways. The classic work of Patterson et al. (2010) developing and implementing the PMTO (Parent Management Training–Oregon Model) provides a striking example of cascading effects from effective interventions in the family parenting system with noncompliant children. Not only did parenting and target child behavior improve as a result of treatment, indicating that the pathway to worse antisocial behavior was averted, but also there were benefits to other members of the family over time, demonstrating unexpected positive cascades.

A Cochrane review of parent-mediated interactions for young children with ASD found evidence for their effectiveness on parent–child interaction outcomes, as well as gains in language comprehension (Oono et al. 2013). This finding might illustrate disruption of a negative cascade of early ASD-related social disability as well as instantiation of a positive cascade for improved social interactions that extends to language.

In an analysis of persistence versus fade-out of intervention effects for children and adolescents, Bailey et al. (2017) argued that there were three strategies with lasting effects, congruent with cascade models. First, skill-building interventions target skills that are malleable, fundamental, and unlikely to change on their own. Second, foot-in-the-door approaches focus on opening doors or boosting key behaviors at just the right time to avert problems or seize opportunities. The third strategy targets improvements in sustaining environments, such as parenting skills in the family or the quality of instruction in school.

When developmental systems theory emerged and took hold in resilience science, frameworks for intervention gave more attention to both the significance of multiple interacting levels for leveraging change, creating synergy through two-generation strategies, and the possibilities for interventions to interrupt negative cascades and trigger positive ones (Masten & Cicchetti 2016). Interventions for depressed mothers with young infants provide an important example with respect to one of the most harmful risk factors for child development. In their review of the intervention literature on depressed mothers, Goodman & Garber (2017) underscored the importance of focusing on parent skills as well as parent symptoms. They describe the dual strategy of treating mothers' depression and improving parenting skills in order to alter the cascading consequences

of this serious threat to child mental health and development. A consensus study by the National Research Council & Institute of Medicine (2009) on the topic of depression in parents recommended combined approaches of this kind. Systematic reviews of parenting interventions across cultures support the efficacy of parent training for improving both parent and child mental health and behavior, as well as parenting skills (Goodman & Garber 2017).

Multigenerational and multisector approaches can be observed in many humanitarian aid programs and interventions sponsored by UNICEF, the World Bank, and other nongovernmental organizations. These agencies have the mission of promoting healthy development and investing in the resilience of children and youth at risk due to war, displacement, severe poverty, epidemics, economic crises, and natural disasters (Lundberg & Wuermler 2012, Masten & Motti-Stefanidi 2020, Yoshikawa et al. 2020).

One of the most intriguing new lines of inquiry in research on risk and resilience with implications for both basic and applied science was inspired by the concept of differential susceptibility or varying sensitivity to context, based on evolutionary theory (Belsky & Pluess 2009, Ellis et al. 2011). This concept represents moderating models wherein risk or resilience effects depend on the context; sensitive individuals are potentially harmed more by negative life experiences (a vulnerability effect) but also benefit more than less sensitive children from positive environments, including interventions (a promotive or protective effect; Masten & Cicchetti 2016). This raises the possibility that the same children or parents who are doing poorly in contexts of high risk and adversity may respond well to interventions focused on improving adaptive systems (e.g., EF or parenting) or lowering risk levels through direct cash transfers or other resources (e.g., housing) and reducing structural inequality.

A related new area of research based on evolutionary theory is the idea of stress-adapted skills or “hidden talents” (Ellis et al. 2020). In this framework, young people ordinarily viewed as maladaptive on the basis of their performance in age-normative developmental tasks, such as school achievement, are reconsidered in light of their lived experience. Some youth viewed as maladaptive in a school context (e.g., youth who misbehave at school or avoid school altogether) may have stress-adapted skills developed from surviving on the streets or in other high-risk situations. Examples of these skills include fast information processing about safe or dangerous situations and cognitive flexibility. Appreciating the potential value of these skills could change the perception of maladaptive youth (by others and by young people themselves) and also inform intervention efforts to redirect these skills for success in normative contexts.

CONCLUSIONS AND FUTURE DIRECTIONS

Resilience science is essentially the study of how a system responds successfully to disturbances that threaten to destroy or harm the function, survival, or well-being of that system. The criteria for success are a matter of values and judgment that often vary across disciplines, cultures, and levels of analysis. In the past, ecologists who studied the life cycle of lakes and forests were not too concerned about a single fish or tree or a human individual fishing and walking in the woods, whereas clinical psychologists focused on the health and well-being of individuals or families. Yet ecologists and psychologists alike now recognize that many systems are interacting and interdependent, with the survival and well-being of living systems across the planet at stake.

Individual children and youth depend on many systems for their healthy development, and the capacity for adapting to hazards along the way is distributed across multiple systems, including the individual child. Human resilience develops and changes over time because all of the systems involved in development are interacting and changing, both inside the individual and in their relationships and interactions with their socioecological contexts. This dynamic systems view of



resilience has implications for research and practice aiming to understand and influence pathways to psychopathology and positive development.

Focusing only on risk and vulnerability processes during the period when deficit-focused and diathesis–stress models were prevalent clearly captured only part of the developmental story of psychopathology. The shift to consider resilience perspectives in observations, theory, models, measures, and interventions has given rise to important directions for research, prevention, and treatment. Because of space constraints, we highlight only some of many contributions from a literature that has become extensive and continues to grow as attention turns to multisystem resilience. Although much has been accomplished, exciting new directions for research on resilience are emerging.

Advancing multisystem resilience science requires models and methods for studying resilience across system levels. Modeling dynamic positive change in interacting systems is a methodological challenge, as is the study of coordinated adaptive systems and networks of adaptive processes. Similarly, models and methods for analyzing cascades across system levels are needed to explain both top-down and bottom-up effects of interventions. For example, how do interventions that change families or individual behavior for the better cascade into individual biology to change the epigenome or neurobiological systems for responding to stress? And how do medications that change biochemistry cascade to change behavior and family life?

Research on active protective processes in development at multisystem levels of action, including neurobiological levels, is just beginning. Researchers studying neurodevelopmental disorders are leveraging accumulated evidence for risk markers to interrogate the interacting pathways of risk, protective, and promotive processes leading toward and away from diagnosis and adaptive functioning. There is growing recognition of the transformative potential for combined risk and resilience approaches to enhance intervention science.

Investigators are asking exciting new questions about the active processes that may counter transdiagnostic risk or vulnerability. Research on the intergenerational transmission of protective processes, the interruption of intergenerational risk cascades, and their implications for two-generation interventions is growing.

It will be important to carry out deeper study utilizing multiple methods of stress-adapted skills in youth with lived experience in dangerous environments or situations fraught with discrimination and oppression, and strategies for leveraging those skills to benefit the youth themselves and society. For youth from such backgrounds who succeed in mainstream schools and workplaces, research on biological wear and tear or premature aging is motivating careful study of costs that may be incurred by striving to overcome structural inequality. Moreover, disaster research on war, terror, natural disasters, and epidemics has underscored the importance of social justice and equality for collective resilience.

While research on cultural processes has expanded, additional research is important for identifying unique processes and practices that afford resilience in specific sociocultural contexts. Cultural traditions embody the wisdom and coping strategies of generations of people who have faced common and unique challenges. There is much to learn from a richer understanding of the cultural practices that encode and nurture resilience across generations. Multidisciplinary strategies and multiple methods, including qualitative studies, will be needed (Theron et al. 2015).

Additionally, forced migration is confronting children, families, and humanitarian organizations, as well as receiving societies, with complex challenges, and climate change is likely to generate even more migration. Understanding and supporting positive adaptation in situations of migration and acculturation are going to be crucial for many stakeholders.

More research is needed on the developmental timing of adversity and interventions in relation to protective processes and how best to time interventions for greatest positive impact. When and how to nurture resilience of children in families and schools remain a goal in need of further investigation. Such research will need to include a better understanding of neurobiological plasticity, both naturally occurring plasticity and the potential for interventions to open windows of neural plasticity to reshape adaptive systems. We have just begun to study the possibilities of reprogramming or recalibration of key adaptive systems in development.

Finally, multisystem resilience requires multisystem teams and training to coordinate research and action to integrate definitions, models, and knowledge across system levels. Particularly in the face of large-scale disasters, both those we expect from climate change, terror, or future pandemics and those from unexpected future shocks, preparation and response require coordination and skills from multiple sectors and disciplines. But the benefits of multisystem integration and coordination extend beyond disasters. Promoting mental health and positive development in communities and societies contending with many kinds of risk, vulnerability, and adversity represents a large-scale, multisystem grand challenge that can be informed by including resilience perspectives, particularly when multilevel and multidisciplinary scientists can communicate and coordinate their research.

SUMMARY POINTS

1. Resilience research emerged from studies of children at risk for psychopathology as investigators sought explanations for the striking heterogeneity of development observed.
2. Contemporary definitions of resilience in developmental sciences reflect a dynamic systems perspective.
3. In order to integrate models and knowledge about resilience stemming from multidisciplinary research at multiple levels of analysis, it is crucial to define resilience for scalability and portability across system levels and disciplines.
4. Resilience can be defined as the capacity of a dynamic system to adapt successfully through multisystem processes to challenges that threaten the function, survival, or development of the system.
5. Due to the multilevel, interacting systems involved, resilience capacity is dynamic, distributed across networks of systems, and may cascade across domains, system levels, and generations through diverse processes.
6. There is striking alignment of widely reported resilience factors (the short list) observed in research at different human system levels, including individuals, families, schools, and communities, suggesting that there are fundamental human adaptive systems that coevolved and may act in concert in resilience processes.
7. Interventions that target resilience factors in randomized controlled trials with children and youth at risk for psychopathology support the promotive and/or protective influences of widely reported resilience factors.
8. Some resilience factors, such as effective parenting, social support, or self-regulation skills, may afford transdiagnostic protections against psychopathology; therefore, interventions that bolster or protect these factors may also yield transdiagnostic protective effects.



FUTURE ISSUES

1. Are there active neurobiological compensatory or protective processes triggered by developmental deviations in brain development or function?
2. Are there transdiagnostic protective processes at multiple system levels that buffer the effects of stress at multiple system levels?
3. What methods and measures are needed to model dynamic multisystem resilience?
4. When and how can exposure to adversity improve specific adaptive systems?
5. What are the costs and trade-offs of successful adaptation to chronic violence or injustice?
6. Why do some interventions have positive cascade effects whereas others fade out?
7. How do we train multidisciplinary teams for coordinated and collaborative research on resilience to prepare for and respond to multisystem threats?

DISCLOSURE STATEMENT

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