


Special Issue Article

The Future of Developmental Psychopathology: Honoring the Contributions of Dante Cicchetti

Developmental psychopathology as a meta-paradigm: From zero-sum science to epistemological pluralism in theory and research

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Abstract

In a thoughtful commentary in this journal a decade ago, Michael Rutter reviewed 25 years of progress in the field before concluding that developmental psychopathology (DP) initiated a paradigm shift in clinical science. This deduction requires that DP itself be a paradigm. According to Thomas Kuhn, canonical paradigms in the physical sciences serve *unifying* functions by consolidating scientists' thinking and scholarship around single, closed sets of discipline-defining epistemological assumptions and methods. Paradigm shifts replace these assumptions and methods with a new field-defining framework. In contrast, the social sciences are *multiparadigmatic*, with thinking and scholarship unified *locally* around open sets of epistemological assumptions and methods with varying degrees of inter-, intra-, and interdisciplinary reach. DP challenges few if any of these local paradigms. Instead, DP serves an essential *pluralizing* function, and is therefore better construed as a *metaparadigm*. Seen in this way, DP holds tremendous untapped potential to move the field from zero-sum thinking and scholarship to positive-sum science and *epistemological pluralism*. This integrative vision, which furthers Dante Cicchetti's legacy of interdisciplinarity, requires broad commitment among scientists to reject zero-sum scholarship in which portending theories, useful principles, and effective interventions are jettisoned based on confirmation bias, errors in logic, and ideology.

Keywords: developmental psychopathology; paradigm; epistemological pluralism; zero-sum; positive sum

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In early 1991, I enrolled in the first-ever developmental psychopathology course taught at my undergraduate institution. Developmental psychopathology would soon launch on its meteoric growth trajectory, but was not yet fully mainstream.¹ Like any psychology major, I knew what developmental psychology was, and I knew psychopathologists studied “abnormal” behavior. But I'd never seen the terms combined, and although I didn't know it yet, tradition, status disputes, and different epistemological assumptions and methods worked against their integration.² Developmental psychology was focused on normative and comparative development, stability of social behavior and emotion, and longitudinal prediction (McGraw, 1991). Child and adult psychopathology emerged from different intellectual traditions and remained separated in discourse and instruction (Roberts, 2006). Both were largely adevelopmental.

¹In 1990, the last full year before I enrolled, developmental psychopathology was referenced as a topic in 11 publications, with 84 citations (Web of Science, 2024). In 2022, these numbers were 432 and 29,199, respectively.

²Epistemology is the study of knowledge, its acquisition, how we adjudicate between (parse) fact from opinion, and what is knowable vs. unknowable. Epistemological assumptions are the “rules” fields apply to render such judgements.

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Several of the child disorders introduced in the DSM-III (American Psychiatric Association, 1980) were still unvalidated (Gutterman et al., 1987; Rutter & Shaffer, 1980), and a historical bias against mental illness manifesting in children lingered. Insights into processes of and distinctions among constructs including vulnerability and risk, resilience and protection, continuity and discontinuity, and eliciting events versus maintaining mechanisms, were incipient. Although some interdisciplinary discussions were occurring in medicine, where epidemiology, pediatrics, and neonatology were functionally integrated (Philip, 2005), bridges between these disciplines and both developmental and clinical psychology remained nascent (Cicchetti, 1984).

Within U.S. psychology departments, firm boundaries among almost all subdisciplines derived from two transacting forces. First, dominant paradigms in psychology were reactionary in origin built on rejecting one or more core epistemological assumptions of the paradigms they replaced. This dynamic describes both the behavioral and cognitive “revolutions,” two widely acknowledged paradigm shifts the in mid- to late-20th Century (Buss, 1978).³ Behaviorists rejected unobservable and unquantifiable (meta-physical) propositions set forth in psychoanalysis. In turn, cognitive psychologists rejected the behaviorist assumption that

³Throughout, I use the word paradigm in the traditional sense: an organizing framework and set assumptions that determine what scientific questions are legitimate topics of inquiry and the general methods used to adjudicate those questions.



only exogenous determinants of behavior are amenable to scientific inquiry (Beauchaine & Zalewski, 2016).⁴ Like most paradigm shifts, these were zero-sum, with one clear winner and one clear loser. Once supplanted, psychoanalysis and behaviorism withered in single generations (Bornstein, 2001; Watrin & Darwich, 2012). Second, U.S. academic departments have a longstanding tradition of accommodating scientific change through accretion and subsequent cannibalization, not integration (Whitley, 1976). As subfields emerge, new areas of study are added and resourced by reallocating non-discretionary funds and faculty lines over time. In the short-term, vestigial areas of study with faculty adherents to obsolete paradigms remain. In the long-term, these areas are eliminated by attrition. Importantly, the predictive capacity of a particular paradigm may be irrelevant (Kuhn, 1962), with obsolescence determined by forces such as preoccupation of scientists with new methods, incursion of both left- and right-leaning populist ideologies, funding trends, and, at times, principled resistance to adaptation through even small change (Bornstein, 2001; Huniche & Sørensen, 2019; Mede & Schäfer, 2020). In the zero-sum science of paradigm shifts, major contributions to understanding and altering human behavior and its adverse developmental trajectories can be lost, hampering formulation of more effective prevention and intervention programs and compromising the ultimate objective of clinical science—to reduce human suffering (Gee et al., 2022).

Zero-sum science I: Paradigms and paradigm shifts

The term *paradigm shift* was introduced to the physical sciences (astronomy, chemistry, earth sciences, physics) by Kuhn (1962), and quickly taken up by social scientists in economics, psychology, sociology, and beyond (Coats, 1969; Reese & Overton, 1972). Kuhn's original definition is captured in the *American Psychological Association Dictionary of Psychology*, which defines a paradigm shift as, "... substantial and fairly rapid change in the pattern of ideas and assumptions defining the nature of a science and determining the methods and procedures used" (American Psychological Association, 2018). This definition applies best to the physical sciences, where single paradigms that dominate entire fields sometimes give way to new paradigms with greater explanatory reach. Displacement of Newtonian physics by Einsteinian physics is the prototypic example. Confirming Einstein's theory required new experimental methods conducted at previously uninterrogable levels of analysis, changing physics and other fields forever (Holton, 1969). Other paradigm shifts in the history of the physical sciences include transitions to genetic inheritance (Mendel) and evolution by natural selection (Darwin) (see Goldstein, 2012).

Kuhn (1962) acknowledged a major difference between the physical and social sciences, with the latter guided by no single paradigm. Kuhn attributed this to social science being immature, or *preparadigmatic*. The contemporary and more apt interpretation is that psychological science cannot and will never converge on one paradigm given the complexity of human behavior and its transacting determinants across levels of analysis spanning genes to cultures (Beauchaine & Constantino, 2017; Cicchetti & Dawson, 2002; Sanbonmatsu et al., 2021; Weimer & Palmero, 1973). Paradigms in the social sciences are multiple and sometimes obscure (Polsby, 2003).

⁴Situating psychology and its subdisciplines in traditional epistemologic and metaphysic space remains an active area of discourse (Decock, 2018). According to one school of thought, cognitive psychologists redefined epistemology so it aligned with metaphysics, thereby sidestepping the demise of psychoanalysis (Goldman, 1987). Readers who are interested in this and related topics (e.g., cognitive metaphysics, metaphysics) are referred to sources cited herein.

The nature of this paradigmatic heterogeneity is twofold. First, given the complexity of human behavior, all social sciences, to a lesser or greater extent, comprise various subdisciplines with proponents who operate from different theoretical perspectives, carry different epistemological assumptions, and use widely varying methods to test scientific propositions, often at different levels of analysis (Beauchaine & Cicchetti, 2019; Strauman, 2001; Varpio & MacLeod, 2020). No single paradigm can capture such divergence. As a result, few if any paradigm shifts affect entire social science disciplines, and some paradigms cross disciplines (e.g., De Vincenzo et al., 2023). Second, paradigm shifts are often slower than Kuhn (1962) described. Some competing paradigms coexist in equilibrium for many years before one ascends to prominence (Beauchaine & Haines, 2020). In rare cases, competing paradigms coexist in perpetuity, unknowable future events notwithstanding.

Most paradigm shifts follow periods of intradisciplinary debate. In contemporary psychology, several subdisciplinary themes rise to this level or hold potential to do so. These concern the nature of psychological constructs (De Boeck et al., 2023), the value of inductive (top-down, theory-driven) versus deductive (bottom-up, data-driven) research in clinical science (Achenbach, 2020), phylogenetic versus ontogenetic origins of human emotion (Beauchaine & Haines, 2020; Barrett et al., 2007; Panksepp, 2007), methodologic approaches to longitudinal data analysis (Haines et al., 2024), whether certain subdisciplines should maintain their basic science portfolios or accept populist calls for strictly applied research (Berkman & Wilson, 2021; Mede & Schäfer, 2020), and whether psychology and its subdisciplines should retain their logical positivist identities or abandon/replace them to in response to increasingly common prescriptive and proscriptive ideological dicta (Holman & Wilholt, 2022; Silander et al., 2020).

Examples of inter- as opposed to intradisciplinary paradigm shifts include replacement of clinical judgement with actuarial prediction and empirically derived classification—a change that originated in clinical psychology and was later adopted by psychiatry (Achenbach & Edelbrock, 1978; Dawes et al., 1989); and adoption of the biomedical model of mental illness—a change that originated in psychiatry and was later adopted by clinical psychology (Deacon, 2013). Both paradigm shifts were contentious, and the latter was partly pragmatic; many clinical scientists acceded to biomedical research agendas to maintain and extend their federal funding (NIMH, 2024).

Whether field-defining, subdisciplinary, or cross-disciplinary, the predominant approach to science pits paradigmatic and subparadigmatic hypotheses against one another in a zero-sum game. The prevailing tradition in psychology and other social sciences when writing papers and grants is to juxtapose competing theories and devise hypotheses and experiments to adjudicate a winner. As I discuss below, zero-sum thinking hamstrings progress in the social sciences by relegating useful scientific knowledge from the "losing" paradigm to the annals of history. In clinical science, this can harm clients. I provide three examples below, then discuss how continued pursuit of Dante Cicchetti's transdisciplinary vision affords an enduring, positive-sum solution.

Zero-sum science II: Discarding useful paradigms

Paradigm shifts do not guarantee scientific progress (Kuhn, 1962). Even when progress is realized, scientific knowledge, useful principles, and effective therapeutic techniques from "defeated" paradigms are lost in zero-sum science. The plight of behaviorism provides an example. Although behaviorism has persisted in clinical psychology beyond its lifespan more broadly, use of

behavior modification principles has declined sharply in recent years under longstanding criticisms from cognitive psychology and neuroscience, and, more recently, humanism (Guercio, 2020)⁵. Ardent humanists reject, among other empirically supported treatments, response-cost contingencies in the classroom and applied behavior analysis for treating autism (Anderson, 2023; Elkins, 2009; Jung & Smith, 2018; Moss, 2018). Both are viewed as unethical because they diminish self-determinism (see Footnote 4; Gnauhati, 2022; Smith, 1978). In this instance, rejection of the behavioral paradigm is based on ideological, not practical or empirical grounds—operant reinforcement principles are no less effective in the 21st Century than they were in the 20th Century.⁶

Regardless of where one falls on these paradigmatic debates, abandoning behavioral principles is likely setting clinical science back in its overriding objective to reduce human suffering (Gee et al., 2022). Several recently developed school- and classroom-based interventions that largely ignore and sometimes decry behavioral principles are proving iatrogenic (Foulkes & Stringaris, 2023). Programs that prevent student exposure to anxiety-eliciting and fear-eliciting events, for example, often increase anxiety over time, eroding instead of bolstering resilience (e.g., Jones et al., 2020; Limber & Kowalski, 2020; Travers, 2017; Ttofi & Farrington, 2011). Competent behaviorists would likely have averted such outcomes by spotting reinforcement contingencies that amplify anxiety and reinforce self-narratives of vulnerability (Bellet et al., 2018, 2020).

In some cases, arguments set forth to “defeat” rival paradigms oversimplify core tenets and mischaracterize opponents' perspectives. Skinner, for example, is often described as a naïve reductionist who renounced genetics, neuroscience, and all endogenous mechanisms of behavior (DeBell & Harless, 1992). Those who have read Skinner, however, know he espoused no such position (Zilio, 2016). Instead, he demanded that explanatory mechanisms of behavior be observable and measurable (Skinner, 1963), a perspective consistent with logical positivist philosophy of

⁵In this context, the term humanism may confuse those outside the discipline. Humanism first emerged as a religious philosophy during the Italian Renaissance and was later secularized during the Enlightenment (Ferrone & Tarantino, 2015; Rubini, 2014). These movements emphasized education, exploration, civic engagement, and democracy toward improving the human condition, spawning the humanities. Although contemporary humanism in U.S. clinical psychology also seeks to elevate the human condition, it is more libertarian, promoting self-determination, autonomy, and individual preference over adherence to social mores, institutional norms, educational attainment, and sometimes long-term psychological adjustment (when self-determining agents weigh immediate needs over future mental health, which may not be considered) (Moss, 2018). By definition, behavior modification is other- rather than self-deterministic (Theophanous, 1975).

⁶Here I refer to operant reinforcement only – not to any particular intervention. Operant reinforcement is defined by the Law of Effect, which states, based on hundreds of studies with animals and humans, that behavior is modified by its consequences (for extended discussion see Meehl, 1950). There is no evidence this relation has changed in strength over time across the population and there are strong evolutionary arguments against such change. Consistent with this supposition, across 600 randomized trials, interventions for child mental health problems show similar effect sizes, on average, compared to 40 years ago, with variability depending on the presenting problem and content, including whether and how much operant principles are the mechanism of action (Weisz et al., 2023). This does not mean that efficiency of an operant-based intervention is unaffected by other aspects of the environment, which can influence both efficacy and effectiveness. Delivery schedules vary in timing, consistency, and more, and competing contingencies affect the slope and magnitude of behavior change (Staddon & Cerutti, 2003). The Incredible Years intervention, for example, emphasizes increasing positive parent-child dynamics before implementing rewards and costs for compliant and disruptive behavior, respectively (see Samimy et al., 2022). Failing to do so reduces intervention effectiveness. Moreover, cultural environments high in racism reduce intervention effectiveness in majority Black samples (Price et al., 2022). Thus, one cannot expect operant reinforcement alone to address children's mental illness. The very point of this paper is that understanding human behavior is impossible at single levels of analysis. Expertise across multiple disciplines and subdisciplines is needed to maximize intervention effects.

science⁷ and neuroscientific data of the day (Moore, 1985; Olds & Milner, 1954). Although Skinner overestimated the promise of behaviorism in complex human environments (Gary, 1973), he was not a reductionist, and operant techniques proved invaluable, rivaling and sometimes exceeding the effectiveness of potentially addictive medications for psychiatric disorders (Connors et al., 2001; Wardle, 1990).

When Skinner (1963) wrote his now-famous article on operant conditioning in the *American Psychologist*, psychophysiological methods were being used and had been used for some time to evaluate endogenous responses to reward and punishment, and endogenous correlates of operant conditioning (e.g., Schmidt, 1941). Skinner himself appealed to physiological data to understand mechanisms of operant reinforcement (Lambert et al., 1933). Neural correlates of human behavior simply could not be interrogated until the mid-1990s, when functional neuroimaging became available. In the age of neuroscience, however, the value of which cannot be overstated, Skinner's contributions to understanding human behavior and reducing human suffering are often further diminished (Guercio, 2020; Wakschlag et al., 2017). Operant reinforcement principles—the bedrock of a generation of effective interventions for ADHD, oppositionality, anxiety disorders, and developmental disabilities—may be fading into historical obscurity. Behaviorism lost the zero-sum game (Braat et al., 2020).

In other cases, paradigms with overriding empirical support are supplanted based on oversimplified and mistaken rationales contrasting them with fully integrable “rival” paradigms (Loeb, 2018). Wakschlag et al. (2017), for example, built their case for neurodevelopmental mechanisms of disruptive behavior by eschewing coercion theory (an operant framework)⁸, reasoning that some children who are parented competently show aggression. Rejecting coercion theory by this rationale ignores a robust literature demonstrating its validity, based on two logical fallacies that are surprisingly common in science. First, it presents a false dilemma (*asrumentum falsum dilemma*; see Tomić, 2013). Both neural and environmental mechanisms of disruptive behavior are well-established (Beauchaine & McNulty, 2013; Beauchaine et al., 2017), with their interactions often accounting for more variance than their main effects combined (cf. Crowell et al., 2008).

A corollary of false dilemma is overgeneralization (*fallacy of extension*; see Peters et al., 2022). In social science, exceptions to theories are rarely *ipso facto* evidence of invalidity—human behavior is far too complex for this level of certainty. With such reasoning, Wakschlag et al. (2017) hold coercion theory to an impossible standard that no psychological or neuroscientific theory, including their own, can possibly meet—accounting for every affected person's disruptive behavior. The bottom line: Wakschlag et al. (2017) and Patterson et al. (1989) are both correct. Bridging their findings, however, requires multidisciplinary grand theory, a point I elaborate in later sections.

More broadly, by implicitly prioritizing main-effects at single levels of analysis (here neuroscientific) and using those effects to mistakenly “disprove” and reject any or all others—including those with well-replicated empirical support – we obscure multi-determining mechanisms of psychopathology, fail to detect

⁷Logical positivism requires all scientific conjectures (hypotheses) to be verifiable through external observation and therefore refutable by others (Popper, 1963). Inferences about unmeasured internal states do not meet this criterion.

⁸Coercion theory (Patterson et al., 1989) specifies behavioral and emotional dynamics within families that shape and maintain aggression via negative reinforcement. It is a behavioral theory based almost exclusively on laws of operant conditioning. It is supported by a voluminous literature including true experiments.

important transactions among mechanisms across levels of analysis, and hamstringing our predictive models. The proper question to ask is how to integrate such findings. At present, oversimplified neuroscientific explanations of disruptive behavior have ascended, with coercion theory (behavioral) and extended environment theories (social) fading from prominence.⁹ As important as neurodevelopmental mechanisms are (Beauchaine et al., 2008), this edges the field toward biological reductionism. Interventions derived from or informed by coercion theory have benefitted thousands of children across the U.S. and Europe for two generations, with medium to large effects that in some cases endure and even strengthen into adulthood (e.g., Beauchaine et al., 2005; Dodge et al., 2015; Samimy et al., 2022; Webster-Stratton & McCoy, 2015). Moreover, biological vulnerabilities predict children's responses to and are changed by these interventions, with direct implications for precision care (Bell et al., 2018).

Identifying interactive mechanisms across levels of analysis is critical to building more effective interventions (Beauchaine et al., 2019a). Zero-sum game science—even when multidisciplinary—discourages transactional model building across levels of analysis, constraining our understanding of psychopathology and its development, and obscuring equifinal pathways to what appear to be single disorders. Cumulative, positive-sum science that integrates new findings into theoretically informed, multiple-levels-of-analysis models is needed (Beauchaine & Constantino, 2017; Cicchetti & Dawson, 2002).¹⁰

In the social sciences, there are many examples of prioritizing single levels of analysis while ignoring known effects at other levels of analysis. Some of these extend beyond clinical science to the field more broadly. In such cases, information can be lost, understanding can be eroded, and our capacity to predict future outcomes, identify those at highest need, and redistribute limited resources can be compromised. This is especially likely when higher-order mechanisms in hierarchical data (e.g., school effects) are tested while ignoring nested effects at lower levels of analysis (e.g., children within classrooms). When this occurs, variance in outcomes accounted for at lower levels of the hierarchy (children, classrooms) is subsumed into the higher-order effect tested (schools). This yields overestimates—sometimes by wide margins—of the higher-order effect (Wampold & Serlin, 2000). In this case, a researcher would overestimate school effects, possibly delivering expensive interventions at the school level when delivery to selected classrooms or individual children is indicated. This principle is illustrated in Figure 1.

The field's recent and long-overdue paradigm shift toward prioritizing physical and mental health disparities provides an example (Carter & Mazzoni, 2021, Knerr & Fullerton, 2012; Wallace, 2013). Disparities research enjoys a rich if not representative history in social and community psychology, and is now a major focus of clinical psychology (Carbado et al., 2013, Major, 1994), Foundational contributions to the field, which extend back four decades (Ulbrich et al., 1989; Vega & Rumbaut, 1991), identify predictors of disparities at intrinsic (e.g., temperament, attachment, social cognition, coping style), family (e.g., housing stress, single-parenthood, coercion) and other extrinsic levels of analysis (e.g., discrimination, institutional racism,

neighborhood cohesion, culture) (Case et al., 2018; Dankwa-Mullan et al., 2010; Evans et al., 1994; Keppel et al., 2005). As the field matured across decades, this work included increasingly sophisticated multilevel measurement and analysis strategies to disentangle overlapping individual, family, institutional, geographic, and other effects (e.g., Balsam et al., 2005; Evans et al., 2018). More recently, similar multilevel strategies have been used effectively in research on mental health outcomes among children and adolescents with intersecting identities (e.g., Hahn et al., 2024; Kern et al., 2020).

Assumptions undergirding multilevel analysis include (1) multidisciplinary approaches are needed to identify and disentangle all essential contributors to mental health disparities (Fleming et al., 2008), and, (2) both intrinsic and extrinsic factors must be accounted for to understand synergistic effects (Intrinsic Vulnerability \times Extrinsic Risk interactions) that render some individuals in environments of discrimination and racism far more likely to have existing mental health problems, to develop future mental health problems, and to experience early mortality. Only by understanding multilevel Person \times Environment interactions can we effectively target these individuals with potentially life-saving preventive interventions and treatments (Holmes et al., 2008). As we work toward the desired ideal of eliminating discrimination, racism, and stigma, delivering resources to the most vulnerable in such contexts minimizes current suffering.

Several authors have argued against multidisciplinary and multilevel analysis of physical and mental health disparities on moral grounds (e.g., Knerr & Fullerton, 2012; Wallace, 2013). These calls are based on two concerns. First, limited progress has been made toward closing disparities or altering deteriorating mental health among racial minorities or other underserved sectors of the U.S. population. Second, focusing on and documenting individual-, family-, and community-level contributors to mental health problems among marginalized groups either is or will be construed as blaming the victim.

Concerns over limited progress are legitimate and deserve our attention and research focus. Although stagnated progress in treating mental illness is a general problem for the field (Bommersbach et al., 2023; Brennan, 2022), stakes are higher for racialized groups and other marginalized members of the population who already show higher rates of morbidity and mortality than others. Toward addressing and acknowledging the pervasive and persistent nature of mental health disparities, the National Institute of Mental Health recently published their *Strategic Framework for Addressing Youth Mental Health Disparities* (NIMH, 2023), which codifies and sets funding priorities for closing knowledge gaps in environmental, biological, cognitive, emotional, and behavioral mechanisms of mental health disparities—i.e., at multiple levels of analysis.

Better understanding of common, unique, and diverging mechanisms of risk within and across U.S. subpopulations (e.g., sex, race, sexual orientation, gender identity, socioeconomic status, etc.) is essential to simultaneously and effectively target relevant group- and individual-level mechanisms across levels of analysis. True transdisciplinary research—in contrast to multiple but insular lines of research contributed by separate disciplines—is a historically recent development with uncharted potential for bringing interventions to children and families who need them most. With positive-sum science, important work on structural racism, discrimination, and stigma need not be deprioritized (e.g., Acker et al., 2023; Hatzenbuehler et al., 2010).

⁹According to Web of Science, non-self-citations to coercion theory fell 25% between 2018 and 2023.

¹⁰Some have referred to “infinite-sum” science (e.g., Loeb, 2018), which implies that all findings are of equal merit and that all epistemological assumptions are compatible with scientific exploration. This is a more extreme position than I advocate so I avoid the term throughout.

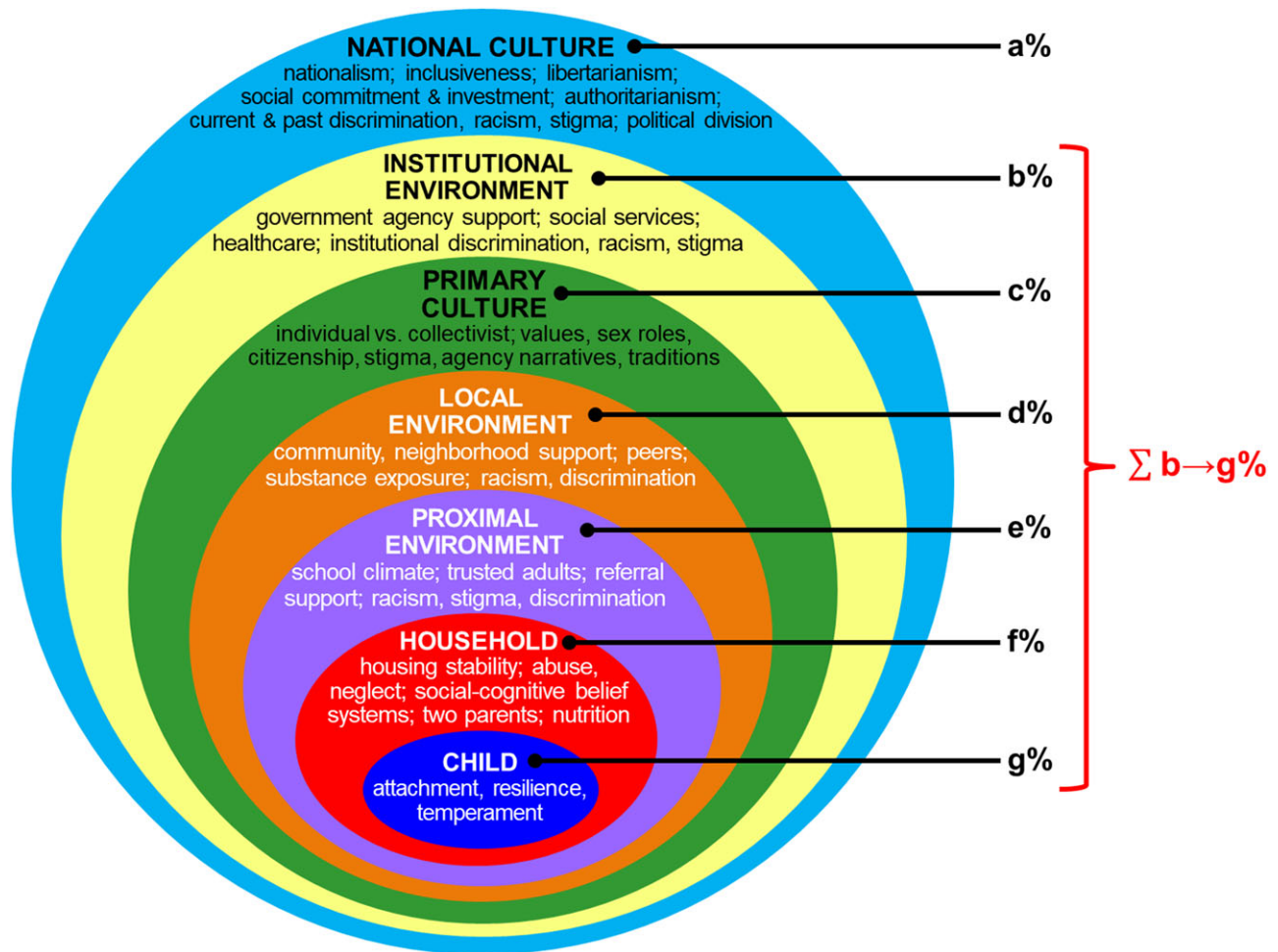


Figure 1. A nested hierarchy of influences on child development and behavior (e.g., depression), with arbitrary percentages of variance accounted for at each level of nesting. To simplify, I assume (1) only individual-level and environmental contributors to depression, (2) error-free measurement, and (3) non-overlapping and non-interacting effects. Variance attributable to each level of nesting can be ascertained with data collected at each level using multilevel (hierarchical) modeling. When all such data are included in the model but only institutional environment is tested, the effect size for institutional environment is overestimated as the sum of $b \rightarrow g$ because variance at all lower levels of the hierarchy is subsumed in the effect. Variance attributable to national culture (a) cannot be quantified without data from multiple nations. Collecting such data should be prioritized in years to come.

In our own work, we are combining information from multiple institutions (local healthcare systems, departments of health, Census Bureau, vaccine uptake) and levels of analysis (medical conditions, prenatal visits, parental ACE exposures) and using machine learning to identify underserved families with expecting mothers in their first trimester who are least likely to attend child well-visits and receive other forms of pre- and postnatal care (Beauchaine & Fox, 2023). We then send community mental health workers directly to mothers' places of living, including homeless shelters, to provide those services. Some participating mothers attend brief focus groups to improve program efficacy moving forward (see Carter & Mazzoni, 2021). Only by collecting data across all available levels of analysis can we effectively redirect critical services in an existing system of care to those members of underserved communities who need them now. Focusing exclusively on institutions precludes the granular understanding needed to accomplish this objective. Every sliver of data available is needed to maximize prediction accuracy. In this case, the zero-sum framework compromises our understanding of disparities and erodes our capacity to predict current and future utilization of care. Individuals within their communities are adversely affected.

Interim summary

Paradigmatic science is often a zero-sum game. Paradigms, theories, hypotheses, and measurement models are pitted against one another, with proponents on each side seeking "wins." In a zero-sum context, such wins limit scientific progress by relegating useful findings, principles, and interventions from the "loser" to the annals of history. Many such wins are dubious given (a) rejection of established theories based on ideological over empirical grounds; (b) oversimplification of rival paradigms and mischaracterizations of their proponents' perspectives; (c) logically suspect arguments based on false choices and overgeneralizations; and (d) the practice of testing superordinate effects in nested data structures while ignoring subordinate effects. The common throughline in these items is prioritization of one's preferred paradigm, epistemological assumptions, and methods as means of knowing. This needn't be intentional and likely isn't much of the time. Confirmation bias is well-documented in social science and is not a sign of malice (e.g., Hergovich et al., 2010). At the same time, it curtails scientific advances and is amplified in the zero-sum game context many scholars are socialized in. My assertion here, which I

devote the remainder of this paper to, is that the current zeitgeist of multidisciplinary science, although a crowning achievement of developmental psychopathology to date, is necessary but insufficient for overcoming zero-sum thinking and the constraints it imposes on transformative social science. Positive-sum science requires a step forward to paradigmatic and epistemological pluralism.

Developmental psychopathology: From multidisciplinary to epistemological pluralism

Acknowledging the daunting complexity of psychopathology is historically recent (Cohen, 2016; Hall et al., 2016). Determinants and correlates of human behavior, including psychopathology, are orders of magnitude more complex than understood two decades ago, when, for example, psychiatric geneticists still assumed oligogenic vulnerability to psychopathology. Since then, cross-disciplinary research has implicated thousands of vulnerability genes (Ripke et al., 2013); identified overlapping genetic risk to multiple disorders (Cross-Disorder Group of the Psychiatric Genomics Consortium, 2013); specified complex genetic, epigenetic, hormonal, and environmental determinants of brain function (Beauchaine & Constantino, 2017); and demonstrated nonlinear interactions among neural systems in affecting human behavior (Beauchaine & Hinshaw, 2020; Haines et al., 2020). Many more etiological inputs could be described. In this context, valuing multidisciplinary research is unsurprising, but it hasn't always been this way.

Among Dante Cicchetti's sure to be enduring contributions to developmental psychopathology—and there will be many—is the overarching, integrative inclusiveness he brought to the field. Cicchetti saw the benefits of engaging with and bridging to a wide range of disciplines with varying epistemological assumptions, research foci, and preferred analytic methods. This theretofore unseen inclusiveness is evident in his earliest writing in this journal: the first four pages of the first issue of *Development and Psychopathology*, where his first editorial appeared (Cicchetti, 1989). Cicchetti stated, "... developmental psychopathology is a comprehensive approach which strives to integrate elements derived from the fields of developmental psychology, clinical psychology and psychiatry, epidemiology, sociology, and both the physiological sciences and neurosciences" (pp. 1–2; see also Cicchetti, 1990). Since then, Cicchetti has co-edited, with carefully chosen colleagues across various disciplines, over 60 special issues in which experts from diverse fields and perspectives contributed. Over the 35-year period beginning in 1989, interdisciplinary research emerged where it had not been before, elucidating ontogenic and transactional influences on psychopathology across levels of analysis spanning genes to cultures (Beauchaine et al., 2018; Masten, 2006). This work specified multicausal pathways to assumedly single disorders, described divergent outcomes from common etiological starting points, and identified biological and behavioral mechanisms through which interventions exert their effects (Beauchaine & Slep, 2018; Beauchaine et al., 2019b; Bell et al., 2018).

Cicchetti facilitated—more than any other scholar—progression of developmental psychopathology from unidisciplinary to multidisciplinary to interdisciplinary to transdisciplinary. It is difficult to overstate the value of this sweeping contribution and the extent to which disciplinary boundaries were diffused (Beauchaine et al., 2018). A challenge for the next generation is to finish this work. Despite overwhelming progress, further interdisciplinary integration is essential for constructing the grand

theories needed for groundbreaking insights into psychopathology and its development, and for leveraging those insights into more effective prevention and intervention programs. Such progress depends on (1) reformulating zero-sum science; (2) breaking down lingering disciplinary hierarchies; and (3) confronting confirmation bias whereby scientists reject other's out-of-discipline and out-of-paradigm scholarship using higher standards of evidence than they use to reject within-discipline and within-paradigm science. Addressing these points is essential for constructing integrative grand theories without persistently and repetitively "pulling the curtains down" on one another.

Epistemological pluralism places a broad range of paradigmatic assumptions, scientific perspectives, and methodological practices on equal footing, eliminating disciplinary hierarchies in transdisciplinary research teams and in science more broadly (Healy, 2003; Miller et al., 2008). Major assumptions of epistemological pluralism are that no single paradigm or perspective can capture all aspects of complex phenomena, and no discipline or paradigm holds *a priori* predominance in interpreting events, rejecting paradigms, or constraining research agendas (Wegerhoff et al., 2022). Epistemological pluralists recognize the complexity of natural phenomena, juxtapose that complexity with the limits of knowledge for single human agents, acknowledge the overwhelming level of detail needed to understand even local problems and events, and how that level of detail obscures and biases one's interpretations of distal problems and events even within one's field (Potochnik, 2017). According to this perspective, understanding is maximized by taking a transdisciplinary but "modular" approach to studying complex phenomena, combining multiple models built by "local" experts into a grand theoretical account that exceeds the sum of its parts (Ruphy, 2016). I provide an example below.

Epistemological pluralism encourages humility in science, respect for paradigmatic assumptions in other disciplines, and trust in others' training and competencies. Few neuroscientists with expertise in designing tasks to elicit, test, and construct theories about neural reactivity to appetitive, aversive, and emotion-eliciting stimuli (neural substrates of operant conditioning) in the constrained environment of an MRI scanner can fully appreciate or make optimally informed scientific judgements about work by a behaviorist with expertise in operant conditioning, functional analysis of behavior change, and designing response-cost contingencies for different populations at different ages in different settings. Neither can many so-described behaviorists fully appreciate or make optimally informed scientific judgements about advanced work in neuroscience. By themselves, these are complex roles, and both neuroscientists and behaviorists, depending on the scope of the project, are viewed as essential contributors to a transdisciplinary research team. Their "modular" expertise provides for fruitful cross-pollination of ideas, with potential for scientific innovation. Although the transition from single principal investigators to multiple principal investigators on NIH grants is facilitative in this regard, it is a nominal move if not implemented in practice.

With epistemological pluralism and positive-sum science, paradigmatic heterogeneity is a strength, not a limitation. This provides opportunities for growth and construction of overarching theoretical models of psychopathology that accommodate all levels of analysis simultaneously. It discourages scientists from making common errors in logic, including (a) rejecting grand theories based on refutation of local conjectures, and (b) rejecting grand theories that do not account for every person who exhibits a specific behavior or disorder. In both cases, we throw the baby out

with the bathwater. Paradigmatic and epistemologic humility and acknowledgement of the complexity of psychopathology obviate these impulses.

I illustrate these principles in Figure 2, using our neurodevelopmental model of antisocial behavior, which describes how biological vulnerability (heritable trait impulsivity) is shaped by environmental risk (e.g., family coercion, deviant peer affiliations, early substance exposure, discrimination and racism) and protection (e.g., trusted adults, neighborhood cohesion) across development (Beauchaine et al., 2017; Beauchaine, 2020; 2019a; McDonough-Caplan & Beauchaine, 2018). Although I cannot review all effects here, each has well-replicated local support. I acknowledge this is *one* common pathway to antisociality, not the *only* pathway, that specific vulnerabilities and cumulative risk exposures extend beyond the examples provided, and that such exposures vary in type and timing within individuals across development. Although not represented in Figure 2 given space limitations, these caveats are readily accommodated.

Certain other predisposing vulnerabilities, such as in utero substance exposure and head injury, are not readily accommodated, and require different models given different core mechanisms.¹¹ I also recognize that heritable temperamental impulsivity does not determine adult antisocial behavior, and that in contexts devoid of risk, progression past ADHD (the diagnostic manifestation of functionally impairing impulsivity) is unlikely. I refer interested readers to selected lab publications for further details (e.g., Beauchaine & McNulty, 2013; Beauchaine et al., 2017; McDonough-Caplan & Beauchaine, 2018; Rutter et al., 1964).

Developmental psychopathology as a metaparadigm

Just over a decade ago, Micheal Rutter (2013) considered the question, in this journal, of whether developmental psychopathology initiated a paradigm shift in clinical science. After cataloging discoveries within the field related to several childhood-onset disorders, Rutter listed defining achievements, including identification of environmental risk mediators, expanding work on gene-environment interaction and correlation, demonstrating effects of parental mental illness on offspring, specifying Vulnerability \times Stress interactions, modeling ethnicity effects, and mapping continuities and discontinuities in behavior. Rutter concluded that developmental psychopathology indeed initiated a paradigm shift. He went on to explain (p. 1210):

... DP is not a theory and it is not a discipline. It is not a theory because it does not propose an overall explanatory account. It is not a discipline because it does not refer to a definable body of knowledge, and it does not involve a single profession. Rather, it constitutes a conceptualization that leads to crucial questions on continuities and discontinuities and which is dedicated to the discovery of mediating mechanisms.

I have always found Rutter's conclusion and explanation to be somewhat at odds. The success of developmental psychopathology

¹¹In some cases, boundaries between heritable vulnerability and environmental risk blur. High stress incurred by mothers during pregnancy through, for example, housing insecurity or violence exposure, is transmitted to offspring through circulating glucocorticoids (Mead et al., 2010). The striatum, a brain region implicated in impulsive behavior and decision-making (Wise, 2004), has a dense distribution of glucocorticoid receptors. Fetal overactivation of these receptors modulates development of the striatal dopamine system and its functional reactivity to exogenous events, likely for life, similar to effects of direct exposure to adversity in early childhood (e.g., Birn et al., 2017). As I emphasize herein, the utility of grand theoretical models is not in their capacity to list all possible etiological mechanisms, but rather to *organize*, communicate concepts and principles, stimulate thought, and generate new ideas, thereby encouraging pluralism.

is undeniable. It is surely an impressive organizing system with broad reach that redirected research emphases of many scholars. Continuity, discontinuity, and mediation were sharpened as areas of focus by developmental psychopathologists, but these, as Rutter alludes to, preexisted in sociology (continuity and discontinuity; e.g., Robins, 1966) and social psychology (mediation; Baron & Kenny, 1986). And if developmental psychopathology was a paradigm shift, what was it shifting from? Almost all of the disciplines it touched, along with their defining scientific paradigms, remain intact (e.g., developmental psychology, epidemiology, clinical psychology, education, psychiatry, etc.). Even in clinical psychology, where many adherents reside, most graduate programs are split along child and adult lines, just as they have always been. Major breakthroughs at biological levels of analysis, such as genome sequencing, epigenetic divergence across development, and neurobiological substrates of human behavior, came from the usual suspects and were later adopted and extended by developmental psychopathologists (Fowles, *in press*; Fraga et al., 2005; Heather & Chain, 2016). Research on Gene \times Environment interaction originated in the adult psychopathology literature (Gottesman, 1963), and advanced techniques for modeling nested longitudinal data originated in education and criminology (e.g., Nagin & Land, 1993; Rogosa et al., 1982). Multiple-levels-of-analysis research rightfully ascended (Cicchetti & Dawson, 2002), but this too was organizational, with no new levels added. Although resilience research (e.g., Masten & Cicchetti, 2016) and work on the neurobiology of stress responding (e.g., Loman & Gunnar, 2010) may be considered exceptions, they too have firm roots in literatures that emerged before developmental psychopathology's inception (Gunnar, 2021; Luthar, 2006).

Rutter's (2013) conclusion seems to follow expectations of paradigm shifts in the physical sciences – rapid changes in assumptions that affect the methods and procedures used across entire fields (American Psychological Association, 2018). Yet paradigm shifts in the physical sciences are elegant in their simplicity and unity. A round earth, a heliocentric solar system, Mendelian inheritance, evolution by natural selection, and special relativity can all be distilled to a single idea, expressed in one or two sentences, and connoted by a single epistemology. They are generally unavoidable by members of the scientific community of physicists, chemists, etc. even by those who might advocate an alternative.

This is not the nature of paradigms or paradigm shifts in the social sciences, where disciplinary and subdisciplinary paradigms and associated epistemologies abound, and where no single paradigm constrains scientific activities of all or even most members of a scientific community (De Vincenzo et al., 2023; Polsby, 2003). Subdisciplinary paradigms tend to be localized to one or two levels of analysis, and may only be vaguely familiar to colleagues in different areas of single departments. This is the very situation where epistemological pluralism is most needed. Developmental psychopathology does not bring about *unity* in the sense of a classic paradigm in the physical sciences. Its collective principles serve an essential *organizing* function for disciplinary and subdisciplinary paradigms that otherwise would not mix. It advances social science by imposing epistemological and paradigmatic *plurality*. It is a *metaparadigm*. Paradigmatic unification in the social sciences is an unrealistic and impractical ideal. No single account can possibly capture all essential aspects of such complex phenomena (Ritzer, 1975; Wegerhoff et al., 2022).

Construed as a metaparadigm, developmental psychopathology holds enormous untapped potential to move the field from

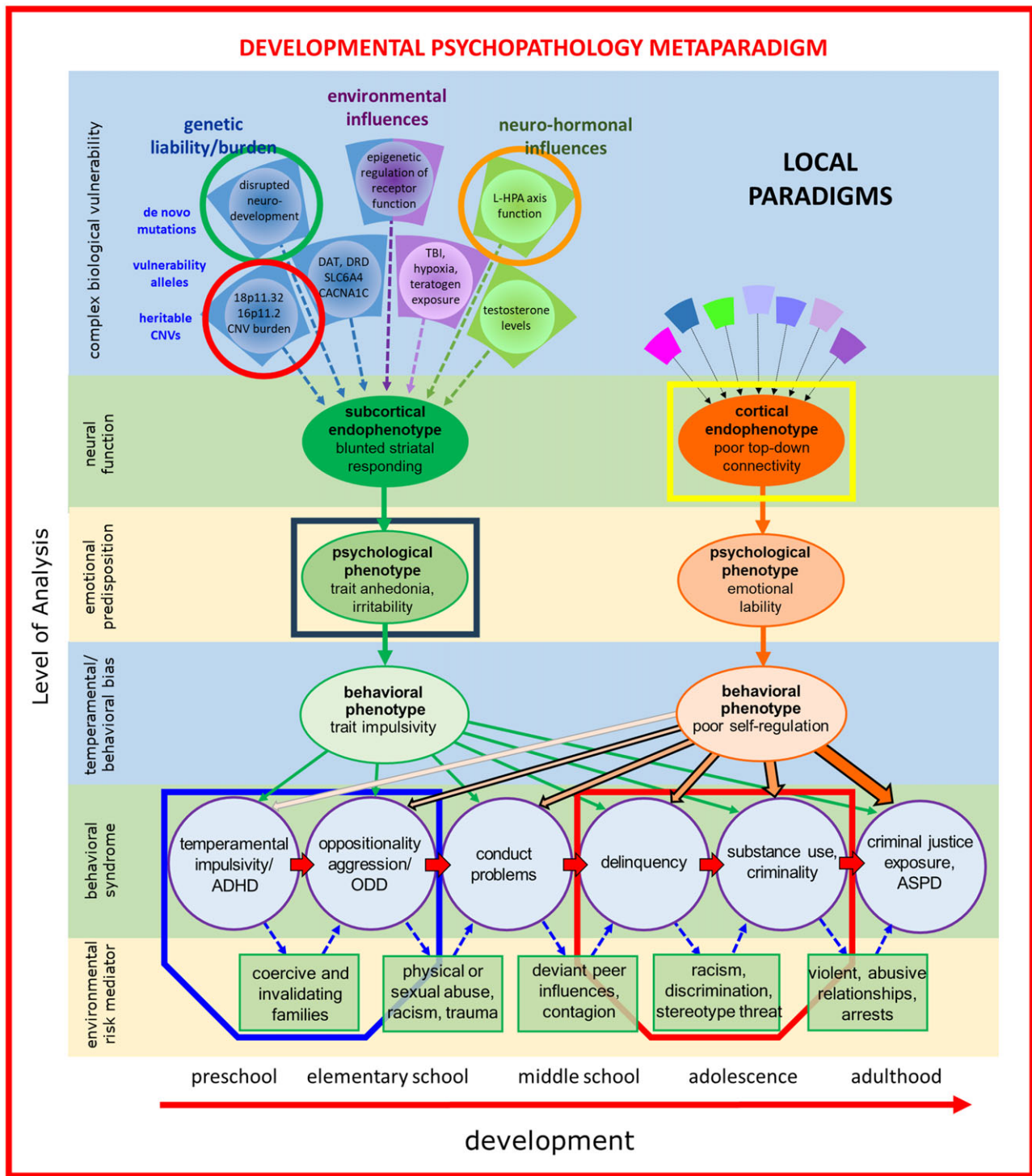


Figure 2. Depiction of developmental psychopathology (DP) as a positive-sum metaparadigm, using the example of externalizing behavior development from preschool to adulthood for trait impulsive boys (Ahmad & Hinshaw, 2017; Beauchaine et al., 2017; Bell et al., 2021; see Beauchaine, 2020 for a parallel model for girls). Bolded text within this figure caption indicates core DP principles. Predisposing **vulnerability** to externalizing **progression** is conferred by heritable trait impulsivity, a primary source of hyperactive-impulsive and combined subtypes of ADHD. **Vulnerability is multifactorial**, and is instantiated across **multiple levels of analysis** including genetic, neurohormonal, neural, emotional, temperamental, and behavioral (other levels of analysis, such as psychophysiological, are omitted). Progression (**continuity**) is potentiated by multiple **environmental risk mediators** (bottom), which change across development depending on context to “pull” affected individuals along the externalizing spectrum. The list of **environmental risk mediators** is incomplete, and in the real world, risk mediators overlap. Trait impulsivity confers risk at all ages, whereas emotion dysregulation takes on increasing importance in later childhood and adulthood via deficient prefrontal cortex **neuromaturation**. **Discontinuity**, which is not depicted, can occur in contexts of **resilience and protection**. Arbitrarily chosen examples of discipline-specific paradigms (colored circles and boxes) dictate local research practices, assumptions, and methods, with no “mandate” of epistemological unity. Neither the inclusive DP metaparadigm, which can be applied to internalizing progression and other disorders (e.g., Hankin et al., 2016), nor the specific theoretical model of externalizing progression, depend on any single local hypothesis, and hypotheses at different levels of analysis are not pitted against one another, as is common in the current zero-sum game context. All relations (arrows) are supported by existing literature (see Beauchaine & Constantino, 2017; Beauchaine et al., 2017).

zero-sum thinking and scholarship to positive-sum science and *epistemological pluralism*. This integrative vision, which furthers Dante Cicchetti's legacy of interdisciplinarity, requires broad commitment among scientists to avoid zero-sum scholarship in which important ideas, useful theories and principles, and effective interventions are rejected based on confirmation bias, errors in logic, and ideology. Although talk of transdisciplinarity is now pedestrian and transdisciplinary research teams abound, our approach to scholarship remains largely zero-sum. Causes are surely many, and likely include (a) our disciplinary history of and dogged adherence to null-hypothesis significance testing; (b) highly specialized journals that, wittingly or unwittingly, demand content fully consistent with local paradigmatic and epistemologic views and assumptions; (c) a highly competitive funding climate that prioritizes innovation over integration; (d) historical and entrenched disciplinary hierarchies; and (e) limited education about and continued effectiveness of confirmation bias, oversimplification, false dilemmas, overgeneralization, and ideological appeals in arguing against and rejecting viable theories, ideas, and interventions.

Moving from zero-sum to positive-sum science is not an all-or-nothing endeavor. Much progress is already behind us, thanks to efforts by Dante Cicchetti and other leaders in the field who established its broad interdisciplinary reach and translational research agenda. It is difficult to imagine where the field would be without the metaparadigmatic, now 35-year influence of *Development and Psychopathology*. As Cicchetti (1989), the only editor to date said in his first editorial, "... the success of this journal, as well as the advancement of developmental psychopathology, is dependent upon our commitment to realizing the potential of the field. I invite you to become an active participant in this process." (p. 3). It is time for the next generation to heed the call.

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