Dai, D. Y. (2019). New directions in talent development research: A developmental systems perspective. In R. F. Subotnik, S. Assouline, P. Olszewski-Kubilius, H. Stoeger, & A. Ziegler (Eds.), *The Future of Research in Talent Development: Promising Trends, Evidence, and Implications of Innovative Scholarship for Policy and Practice*. *New Directions for Child and Adolescent Development*, *168*, 1–21.

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New Directions in Talent Development Research: A Developmental Systems Perspective

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Abstract

Talent development constitutes an important phenomenon of human development; yet it is rarely considered a mainstream topic in the field of child and adolescent development. Conversely, in the field of gifted and talented studies, various talent development (TD) models developed in the past have had minimal interaction with the literature on child and adolescent development, despite the urgent need for TD models and theories that focus on developmental processes rather than individual traits. In this article, I first identify reasons why talent development has been overlooked, and why existing TD models were not able to pick up the slack. I then introduce developmental systems approaches as a new trend in research, and explain how it reinstates the topic of talent development in developmental research, and by so doing enriches our understanding of human development. I then explore the viability of talent development research and theoretical development being guided by the developmental systems framework. Finally, I identify potential contributions of talent development research to the field of child and adolescent development. My overarching argument is that a relational developmental systems approach to talent development provides a new window for the field to explore the nature and development of human potential.

Talent development is a new comer in the repertoire of topics of child and adolescent development. The topic might appear haphazardly in conferences and journals dedicated to developmental research; yet it is not considered a mainstream topic that needs to be tackled systematically and persistently to achieve a solid understanding. This state of affairs is surprising if one believes that research on human development should go way beyond just describing an orderly progression in physical and mental functions that every human being will go through, particularly those biologically canalized ones. Questions regarding the nature and development of human potential and excellence have to be confronted and addressed if developmental researchers are truly concerned with the issue of developmental diversity and, more importantly, the issue of how to promote optimal human development in its highest manifestations such as talent accomplishments and creative productivity.

As someone who has been working in the field of gifted and talented education for more than 20 years while keeping an eye on new developments in developmental research and theory, I cannot help but think about how much would have been gained if a wide array of talent development phenomena drew consistent attention from developmental researchers. Therefore, the purpose of this article is to advance a proposition that talent development is a legitimate but overlooked topic in developmental research, and integrating this topic into the field will significantly enrich our understanding of child and adolescent development and beyond. The article is meant to be tentative, illustrative, and programmatic (and perhaps polemic to some degree), in the hope of evoking new thoughts and rekindling interest in the topic.

To achieve this purpose, the article is divided into four sections. In the first section, I develop a sketch of the history of developmental psychology and gifted and talented studies in order to illustrate why talent development has never become a mainstream topic in developmental research despite decades of research on the nature and development of talent. In the second section, I introduce a developmental systems perspective, and argue that it presents an opportunity to bring a wider range of developmental phenomena, including talent and talent development, into the field of human development. In the third section, I delineate a conceptual framework for such a developmental systems approach to talent development in terms of structural, process, and temporal regularities. I illustrate how this approach helps solve perennial issues such as trait versus process accounts of talent and development, a nature-nurture issue prevalent in developmental research (Sameroff, 2010). In the final section, I provide a synopsis of what insights talent development research and theory can contribute to child and adolescent development, especially regarding the nature and cultivation of human potential in foundational and transitional years of human development.

Two Realms of Developmental Psychology: What Falls Through the Crack

Following Cronbach's (1957) lead on his identification of "two disciplines of scientific psychology," McCall (1981) argued that developmental psychology also suffers from the same schism, between those who studied normative (i.e., species-typical), age-graded structural changes in mental functions (e.g., from Gesell to Piaget; see Horowitz, 1987), and those who study developmental stability of individual characteristics, including personality traits and intellectual functioning (e.g., IQ); such stability was often viewed as heritable based on behavioral genetics research. McCall particularly found it troubling that that these two lines of research went parallel and were never intersected, let alone integrated. What is missing, according to McCall, is an account of *differential development*: people grow to be increasingly different from each other (i.e., evolving individuality) due to both genetic and environmental variations.

McCall (1981) raised many issues that still have currency today. For instance, McCall challenged the assumption of measurement continuity regarding mental functions across ages, particularly when it comes to development of specific strengths and abilities beyond IQ (Lohman & Rocklin, 1995). The sentiment was echoed by the argument that mental functions individuals develop range from highly universal to highly unique ones (Feldman, 2003). Methodologically, it corresponds to the nomothetic-idiographic continuum. The point that individual development may have diverse developmental trajectories and pathways was picked up by Lykken (1992) as a dilemma between depicting parametric properties of a trait (i.e., nomothetic) and understanding its structural properties for individuals (e.g., idiographic). This issue was fully articulated by Molenaar (2004), who argued that using a between-person variance (i.e., interindividual variation) statistical design to infer within-person (i.e., intraindividual variation) structural and functional properties is erroneous because it masks the presence of substantial heterogeneity (see his discussion of *ergodic switch*). The only way these structural and functional properties can be understood from a developmental point of view is to investigate intra-individual developmental changes (similar to the micro-genetic method; Siegler, 1996). More generally, McCall's conceptualization of differential development (his *Scoop Model*) was clearly picked up by later researchers. For example, Wachs (1996, 2000) elaborated on the notion of the individual's *niche potential*, and how nature and nurture jointly determine such niche potential and niche picking processes given a larger context of niche valence involved. What McCall envisioned as a model of differential human development has become a common perspective and increasingly articulated since then (e.g., Bronfenbrenner & Ceci, 1994).

Historically gifted and talented education was very much inspired by differential psychology with its focus on human traits, particularly human

intelligence (Terman, 1925, 1954). However, like the divide Cronbach (1957) and McCall (1981) pointed out, the correlational research tradition generated an enormous body of literature (see Carroll, 1993) based on the psychometric technology and the nomothetic (parametric) assumption, obsessed with a predictive power of a set of "impact traits" (Lykken, 1992, p. 18). But it never confronted developmental processes head-on. For example, early pioneers of talent development, from Terman (Terman & Oden, 1959) to Stanley (1996), inherited a prominent legacy of psychometric definition of giftedness and talent. Based on these theories, gifts and talents are traits of the person involved and work like seeds which, with the proper soil and fertilizers (or catalysts), will grow into what they are destined to become. In other words, gifts are predetermined at birth, and talent development just means bringing them into full fruition (e.g., Gagné, 2005; see Gottlieb, 1998, 2007 for a critique of such a deterministic view of individual development). In the traditional gifted and talented studies, from Terman's (1954) longitudinal study all the way to more recent ones, development is assumed rather than explicated; inferences and conclusions are drawn from long-range predictive efficacy of relevant aptitudes and dispositions, not proximal processes and immediate contexts. To be sure, trait prediction produces many insights (e.g., Lubinski & Benbow, 2006), but its limitations also prevent new progress.

Since 1980s a new group of researchers have looked into the developmental processes with a variety of methods and concluded that "doing" is more important than "being" (Csikszentmihalyi & Robinson, 1986). They criticized the trait or person accounts of talent development as unduly stressing the importance of capacities and traits (e.g., Bloom, 1985; Csikszentmihalyi & Robinson, 1986; Ericsson, Krampe, & Tesch-Romer, 1993; Gruber, 1986). Thus, the nature-nurture war regarding talent continues to date (e.g., Ericsson, Nandagopal, & Roring, 2007; Gagné, 2005, 2009; Howe, Davidson, & Sloboda, 1998), resembling the trait-state debate in the early history of psychology on personality (see Kenrick & Funder, 1988; Mischel & Shoda, 1995 for reviews). In essence, it is a paradigm war between two camps that have different ontological commitments and methodology-based biases (Cronbach, 1957; McCall, 1981). What falls through the crack with such a divide is developmental diversity epitomized by a vast array of talent development trajectories and pathways, and, as McCall attempted to tackle, the issue of how these individual trajectories and pathways are contextually and dynamically shaped by the interaction of endogenous and exogenous forces in situ.

In hindsight, the trait approach and process approach are valid in their own ways. The trait accounts provide a macro-level depiction of talent development from childhood and adolescence to mature, peak performance or productivity in adulthood, with all intervening variables identified along the way, albeit in a broad-brushed manner. In contrast, the process accounts

are based on observations of more micro-level proximal developmental processes and changes, using either experimental and correlation designs to determine mediating mechanisms for high-level performance (e.g., Ericsson & Williams, 2007), or more intimate qualitative accounts based on archival data (e.g., Gruber, 1981), and concurrent (Csikszentmihalyi, Rathunde, & Whalen, 1993) or retrospective reports (e.g., Bloom, 1985; Dai, Steenbergen-Hu, & Zhou, 2015; see Subotnik, Olszewski-Kubilius, & Worrell, 2019 for the most recent research review). The two approach complement each other. However, as Cronbach (1957) warned, the methodological differences create conflicting accounts of origins of talent and polarize the tension between the nature and nurture camps (e.g., Ericsson et al., 2007; Gagné, 2009). In this regard, Renzulli's (1978, 1986) three-ring theory constitutes a borderline case. At a first glance, it identifies three traits (above average abilities, task commitment, and creativity) as constituents of giftedness, but a closer look reveals the developmental nature of the theory: while above average abilities are subject to psychometric measurement given their temporal stability, task commitment and creativity, are contextually bound and developmentally facilitated through person–environmental interactions (thus intra-individual changes, rather than inter-individual differences, becomes more crucial). Using dynamic systems language, task commitment and creativity are *emergent properties* of a person–task functional relationship in situ over a period of time. The transitional character of the three-ring theory is important, as it indicates a new direction in conceptualizing the nature-nurture issue, not unlike the one suggested by McCall (1981).

We might consider trait models as the first approximation in theorizing to map out major "players" or "control parameters," and process models as a further step to dig deeper into how various components, endogenous or exogenous, interact to yield talent development trajectories and outcomes. Trait models typically fall short of specifying micro-level proximal processes that mediate structural and functional changes in talent development. In contrast, when digging deeper into details of micro-level processes, such as finding out how mediating mechanisms facilitate expert performance (Ericsson & Williams, 2007) or how "organization of purpose" leads to great theoretical contributions (Gruber, 1981), process models tend to stress the role of contexts and processes at the risk of *losing sight of* the macro-level landscape of differential development. Under scrutiny, both trait models and process models show inherent limitations in that they do not address problems at a systems level. They assume that a trait or a process functioning alone can be responsible for developmental changes, whereas in real-time talent development, there are always multiple components, endogenous and exogenous, interacting in driving the developmental changes. In other words, developmental systems are relational and interactive (Overton, 2014); they work as complex systems that are *interaction-dominant*, rather than *component-dominant* (Hilpert &

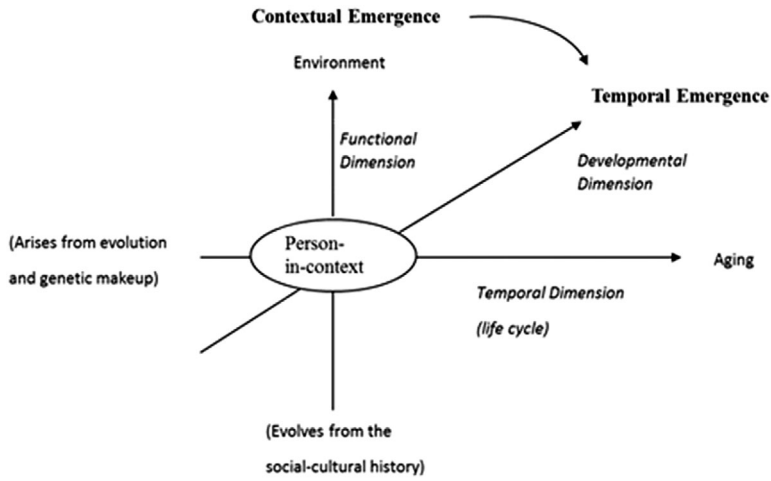
Marchand, 2018; Ziegler & Phillipson, 2012). As Gottlieb (2007) simply put it, "understanding development requires a relational concept of causality" (p. 9). A problem with component-dominant approach is that it assumes how a variable contributes to development of talent (or disorder) *ceteris paribus* (everything else being equal). However, in an interactive world or developmental system, how a variable is functioning depends on how other variables function and how they are related to one another in a system, such that the whole is always larger (and sometimes smaller) than the sum of its parts. A new synthesis is needed, and, fortunately, it is made possible by the developmental systems approach advocated by the developmental science movement.

A Developmental Systems Approach as a New Synthesis

Major advances have been made since McCall's (1981) call for an integrated vision of how individual development takes place, and how one's increasingly distinct individuality (not just psychometrically defined individual differences) evolves. Csikszentmihalyi made one of the early attempts at a developmental systems approach (see Csikszentmihalyi, 1996; Csikszentmihalyi & Robinson, 1986). He insisted that talent be understood in the context of a culture that values specific lines of human development, and that talent is not a fixed quality but evolving and transforming over the course of individual development. Simply put, talent is not a thing but an adaptive process. I have argued for years (e.g., Dai, 2010, 2017) that the scope of talent development as a biopsychosocial phenomenon is such that it behooves researchers to go beyond differential psychology and normative child/ adolescent development to explicate (a) how the person characteristically interacts with a challenging task and social environment (with specific objects, tasks, people, and symbol systems), (b) how the technical, institutional, and cultural supports sustain a particular line of talent development, and (c) how these interactions over an extended period of time fundamentally change structural and functional aspects of the developing person, changes that can be physiological and anatomical (e.g., Sports, Ericsson et al., 2007 and in music, Schlaug, 2001), as well as mental and subjective in nature (e.g., a particular way of feeling and thinking; Gee, 2007).

In view of the trait ("being") versus process ("doing") accounts of talent and talent development, it is necessary to integrate *structural description* (i.e., structural and functional changes and organization set talented individuals apart from their peers) and *developmental process explanations* for these changes (Snow, 1995). This way, the theory is capable of covering a broader range of empirical observations than either a trait account or a process account can do, thus avoiding the two-discipline problem (Cronbach, 1957; McCall, 1981). My main argument is that this kind of complexity can only be tackled by adopting a relational developmental systems approach (Overton, 2014).

Figure 10.1. A schematic representation of three critical dimensions of human functioning and development.



Note: The oval indicates a unit of analysis that intersects the three dimensions. The arrows signify the dynamic nature and directionality of the three dimensions (adapted from Dai & Renzulli, 2008).

How to Develop a Theory of Talent Development Based on a Developmental Systems Framework

A synthesis of different findings across multiple disciplines cannot be achieved unless there is a framework coordinating various empirical findings and theorizing. Over the past decade, my scholarly effort has been focused on developing a theory of talent development that is truly *developmental*; that is, it integrates the role of natural endowment (nature), environmental experience (nature), and the exercise of agency (emergent personal effectiveness) in a coherent manner (Bandura, 1986; Fischer & Biddle, 2006) through a developmental synthesis (Dai, 2010, 2014, 2017; Dai & Spearschneider, 2012; Dai et al., 2015; Dai & Renzulli, 2008). Figure 10.1 is a framework guiding my theorizing.

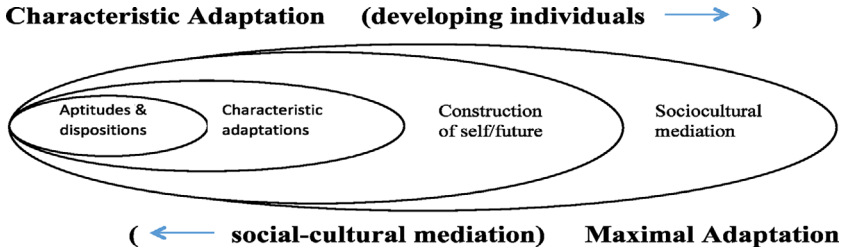
The vertical dimension represents the person–environment interface (i.e., transactional experiences), the horizontal dimension represents a life-span temporal progression (i.e., a future-oriented temporal trajectory), and the diagonal dimension represents the increasingly differentiated and integrated personhood (i.e., individuality) *contextually and temporally emergent* from the person–environment transactions. The three dimensions intersect to form a basic unit of analysis: person-in-context, meaning that a person is investigated and understood as a developing person interacting with specific social-cultural contexts at a specific developmental juncture, with a particular timescale of the course of action (Bronfenbrenner & Ceci, 1994).

Based on this three-dimensional conceptual foundation, a theory of talent development needs to explicate how the person's individuality evolves in terms of structural and functional changes (*structural regularities,* specifying *what* emerges and develops), as the result of specific ways of interacting with a particular task and social environment (*process regularities,* specifying the developmental processes and mechanisms responsible for the emergence of these new properties) with a particular developmental timing and duration (*temporal regularities,* specifying *when* and *how long* it takes for these changes to take place). In short, the three regularities address *the issue of what, how, and when* in an integrated manner. Methods of empirical observations have to honor the contextual, dynamic, and emergent principle reflected in Figure 10.1 (e.g., proximal processes, see Bronfenbrenner & Ceci, 1994; time-intensive and relation-intensive methods, see Hilpert & Marchand, 2018). Through this developmental lens, one can simply see talent development as a prolonged process of human adaptation resulting in outstanding human accomplishments, which either stretches human limits in terms of extraordinary skilled performance (e.g., in sports and performing arts), or makes eminent creative contributions that significantly improve human conditions (e.g., philosophy, science, literature, art, and technology). In short, talent development represents the highest form of human development in terms of realizing and demonstrating human potential at the individual (ontogenetic) as well as species (phylogenetic) level. In the following section, structural, process, and temporal regularities of talent development is discussed, respectively, against of the framework presented in Figure 10.1.

Structural Regularities: Talent as Structural and Functional Changes Indicative of Evolving Complexity of the Developing Person Over Time. A major assumption of developmental systems theory is that the person is an open, dynamic, and adaptive system, undergoing changes in oneself in multiple ways while interacting with the world and exercising its agency. The relational developmental systems approach still honors the traditional orthogenetic principle of development "from a state of relative globality and lack of differentiation to a state of increasing differentiation, articulation, and hierarchical integration" (Werner, 1967, p.126), yet with an emphasis on the developing person as a multi-level, open, and adaptive system, with its interaction with the environment capable of producing true novelty and complexity (Lewis, 2000). To capture this multi-level system at work in talent development, I (Dai, 2005, 2010) developed a multi-level analytic framework presented in Figure 10.2, which shows how the evolving complexity builds up through over time (Dai, 2010).

At Level I are *aptitudes and dispositions* in foundational domains. Aptitudes are more of an ability construct, and dispositions more of a personality one. They are stable traits developed and calibrated in early years of life with certain facilitative social-cultural environments (e.g., exposure to

Figure 10.2. A multi-level analytic framework for understanding the increasing differentiation and hierarchical integration over time in talent development (adapted from Dai, 2010).



chess, or musical experiences). Thus we might identify a child or adolescent's profile of aptitudes and dispositions in foundational domains vis-à-vis affordances and constraints of a wide range of cultural activities, including but not confined to formal education (Lohman, 2005). At least five basic functional domains can be identified as *foundational* for personal effectiveness in a wide range of functional situations: (a) *psychomotor* (executing and coordinating body movements to accomplish complex physical tasks as in the case of most competitive and extreme sports and complex surgical operations), (b) *social* (achieving practical purposes through effective communication, negotiation, collaboration, and leadership), (c) *technical* (making tools and gadgets to enhance effectiveness and efficiency), (d) *expressive* (expressing feelings and desires through imaginative play and artistic representations, such as writing, drawing, acting, singing, dancing), and (e) *intellectual* (reasoning, understanding, explaining, theorizing using mathematics, logic, visual-spatial imaging, or literary means). The above ordering of the five human effectivities has implications for ontogeny as well as phylogeny, but suffice it to argue here that these effectivities help human beings survive and thrive, and thus hold a fundamental adaptive value for us and our ancestors alike. In addition to specific aptitudes manifested as these five foundational domains, we can also identify aptitudes that mainly exert self-regulatory power such as metacognition, similar to metacomponent in the triarchic theory of intelligence (Sternberg, 1985). In contrast to aptitudes, dispositions refer to a set of "nonintellective" or "co-cognitive" personal characteristics that have action potency and regulatory power, such as openness to experience, curiosity, anxiety, conscientiousness, intrinsic motivation, and persistence, that have a direct bearing on developmental potential (Renzulli, 2005; Tannenbaum, 1983).

While a particular profile of aptitudes and dispositions can be conducive to a science or art career trajectory (Feist, 2006; Lubinski, 2004), it is *characteristic adaptation* (CA), that is, characteristic ways the person responds to or seeks certain developmental opportunities that fit one's

strengths and needs, that dynamically carves out a developmental niche (Wachs, 2000) and shapes the self-organization of aptitudes and dispositions toward a particular culturally valued line of talent development (Csikszentmihalyi, 1996). Thus, CA represents a higher-level (Level II) organization of personal adaptation compared to the first-order individual properties such as aptitudes and dispositions as a heterogeneous set. The most powerful evidence for such self-organization comes from research conducted by Lubinski, Benbow, and their colleagues, indicating that directions and trajectories of talent development are shaped by distinct combinations of strengths and weaknesses in mathematical, verbal, and spatial competence (e.g., Lubinski, Webbs, Morelock, & Benbow, 2004; Wai et al., 2009). CA is a concept developed in personality psychology, predicated on the assumption that "human lives vary with respect to a wide range of motivational, social-cognitive, and developmental adaptations, contextualized in time, place, and/or social role" (McAdams & Pals, 2006, p. 208). Compared to trait-level aptitudes and dispositions, CA is a more holistic, organismic construct, more contextually and dynamically situated in specific social contexts, responsive to a particular set of task and social conditions.

Beyond CA, Level III captures a unique human tendency to purposefully initiate and sustain a particular line of talent development. I label it "*construction of self and future*" to highlight its purposive (top-down), proactive, and deliberate nature in self-engendered changes, which is responsible for deep commitment to *maximal adaptation* (MA) to domain-related task environments, as compared to the more situational, spontaneous, self-organized (bottom-up) nature of *characteristic adaptation*. Such an enduring purposive action is evident with a group of technologically talented adolescents who sought out opportunities for learning and self-exploration across home, school, and community in a self-sustaining manner (Barron, 2006). Edelman (1995) emphasized the non-reductionist, contextually emergent nature of this developmental property:

> By selfhood, I mean not just the individuality that emerges from genetics and immunology but personal individuality that emerges from developmental and social interactions. (p. 201).

Finally, Level IV, as shown in Figure 10.1, is the most inclusive level of analysis. It is all-encompassing in the sense that all three-levels of developmental changes, engendered bottom-up (e.g., CA) or top-down (e.g., MA), can be understood in a broader social-cultural context to reveal the social-cultural mediation of these changes (see more detailed description in the section on process regularities). In this sense, one's individuality and culture are not two separate entities but constituent of each other (Rogoff, 2003). Together, this four-level analytic framework helps analyze a cascade of developmental changes undergirding talent development.

In addition to internal changes and transformations responsible for an increasingly powerful representation of some aspects of the world and the emergence of *modus operandi,* through increasing differentiation and hierarchical integration, structural and functional changes so delineated have a social-contextual dimension. From a population viewpoint, different individuals, given their unique experiences as well as developmental potential, will become more or more different from each other, not only due to their profiles of aptitudes and dispositions, but also due to the proximal processes of their characteristic adaptation and more purposive life choices and commitments in particular social-cultural contexts. In other words, structural regularities so defined also capture properties of the *social distribution of talent*: some may be more prone to becoming engineers and others artists, given a range of experiences and choices; some become regional major players, and others international-caliber players. Talent development occurs in the context of a particular developmental corridor in which the person navigates and negotiates a pathway toward success and self-actualization; acts of circumvention and compromise are not unusual (Heckhausen, Wrosch, & Schulz, 2010).

In addition to internal and social-distributional characteristics of developmental changes, structural regularities themselves also lend to an analysis of the continuity and discontinuity of individual development. In the early phase of development, individual differences in aptitudes and dispositions may be quantitative in nature (i.e., differential effectivities in foundational domains found are a matter of degree). However, when cumulative changes in advantages and inclinations build up to a critical point, not only developmental discontinuity takes place (hence phase transition); individual differences in talent become a matter of kind. In terms of the universal-unique continuum (Feldman, 2003), talented individuals show increasingly qualitative differences, especially with respect to their knowledge base, skill sets, and ways of thinking; they develop a modus operandi that is highly tuned into a particular set of task constraints. In this sense, the increasing differentiation and integration in terms of domain-specificity of individual development is a fundamental source of developmental discontinuity (see Dai, 2010 for detailed discussion).

Process Regularities: Interactive Cognitive, Affective-Conative, and Social Processes That Propel Developmental Changes. Talent development is fundamentally a cultural phenomenon, not a natural one (Csikszentmihalyi & Robinson, 1986). Almost all talent domains, including those as basic as linguistic systems and mathematics (let alone science and art), are invented cultural artifacts, and thus *biologically secondary* (Geary, 1995); namely, they are not innately built into our genetic codes or hard-wired in our biological system. To use the language of evolutionary biology and psychology, they are *exaptations*, that is, new characteristics or structures that are co-opted for new function or utility (see Gould, 1991). In order to understand the genesis of talent as well as specific talent

trajectories and pathways, talent-related structural and functional changes have to be situated in social-cultural contexts, and understood as *contextually and temporally emergent* through real time person–environment interaction (Figure 10.1), what Bronfenbrenner and Ceci (1994) called *proximal processes*:

> [H]uman development takes place through processes of progressively more complex reciprocal interaction between an active, evolving biopsychological human organism and the persons, objects, and symbols in its immediate environment. To be effective, the interaction must occur on a fairly regular basis over extended periods of time. Such enduring forms of interaction in the immediate environment are referred to as *proximal processes*. (p. 572)

Thus, structural and functional changes in talent development have to be understood as necessitated by task demands and cultural expectations, and facilitated and sustained by endogenous forces, often with necessary exogenous technical and institutional support.

The process view of talent has several distinct features. First, it indicates the primacy of action and the real-time exercise of personal agency vis-à-vis a task environment in talent development. In other words, talent itself is an emergent property of an evolving functional relationship in context and over time, depending on affordances and constraints provided by a task environment and effectivities manifested by the person as self-organized responses to task demands and social challenges. The principle of performance before competence applies here (Vygotsky, 1978). Second, it highlights the self-organizing nature of characteristic adaptation (CA) as arising from one's profile of aptitudes and dispositions, and the purposive nature of maximal adaptation (MA) to stretch one's limits with the technical and institutional support. As Bronfenbrenner and Ceci (1994) pointed out, developmental potentials for development "are not merely passive possibilities but active dispositions expressed in selective patterns of attention, action, and responses" (p. 572). By emphasizing the importance of the intensity and duration of the transactional experiences, which they called *proximal processes*, they in effect argued for *functional autonomy* (Allport, 1961) of person–environment transactions; that is, the effectiveness of such a functional system we call *talent* is not reducible to genetic differences in capacities or predispositions (see also Dai, 2005, for a non-reductionistic, emergentist argument).

Temporal Regularities: The Timing and Duration of Transactional Experiences Critical for Optimal Talent Development. As shown in Figure 10.1, the interactive process of cognitive, affective-conative, and social forces (vertical dimension) that gives rise to structural and functional changes (diagonal dimension) only takes place and evolves at specific developmental junctures and with a temporal trajectory toward future, which I call *temporal emergence* (horizontal dimension; see Figure 10.1). *Temporal*

regularities specify the developmental timing and duration of transactional experiences as critical for optimal talent development, sometimes even as a make-or-break moment for talent development.

First, the developmental timing of the onset of talent development (and thus exposure) matters. In Evolving Complexity Theory (ECT; Dai, 2017), the developmental timing and duration of transitional phase is critical for CA, so is the timing of transition from CA to MA. Simonton's (1999) emergenic-epigenetic model of talent views the right person (with particular genetic potentials) in the right place (right exposure) at the right time (the right timing) as determining whether one can "make the cut," so to speak. Dai and Li (under review) show that early college entrance by 3 years to a STEM program as indicative of early transition to maximal adaption led to an accelerated rate of talent progression and a ten-year advantage in terms of the timing of early career accomplishments. Such a Matthew Effect (Ceci & Papierno, 2005) is attributable to both individual-level cognitive and motivational advantages (highly committed and intensified effort), and institutional support (Merton, 1996).

Second, the duration of proximal processes in all phases of talent development matters with respect to ultimate talent accomplishments for two main reasons. First, developmental changes are gradual; quantitative changes in structure and function (a matter of degree) are accumulated over time to reach a critical point of phase transition and yield qualitative changes. Second, talent development is a survival game. As all untenured faculty members know, maintaining a trajectory of a focus and productivity is of paramount importance up to the date when the tenure decision is to be made. By the same token, it matters as to how much staying power one has (e.g., whether an athlete can maintain a competitive edge, or whether an adolescent can sustain a strong scientific interest). In the expertise literature, there is a well-documented "10-year rule" (Ericsson, 2006; Simon & Chase, 1973; but see Hambrick et al., 2014); that is, it takes roughly 10 years or 10,000 hours of serious work and intensive training or deliberate practice (i.e., MA) to become an expert in a professional field. Temporal regularities allow us to predict who will survive and thrive, and who will opt out on their way to talent accomplishments. More importantly, the knowledge of temporal regularities allows us to optimize the developmental timing and duration of transactional experiences, given what we know about domain differences in this regard (Subotnik, Olszewski-Kubilius, & Worrell, 2011).

Summary. In sum, structural, process, and temporal regularities as reflecting different dimensions of a developmental system, when explicated in an integrated manner, will provide a unified theory of talent development, which is the goal of ECT (Dai, 2017). Ramifications of talent development in specific domains (science vs. art, or within a domain, poet vs. playwright) can be sorted out through a detailed analysis of affordances and constraints of a specific cultural activity at particular developmental junctures. Such a unified theory of talent development will be an integral

part of developmental science, informing the policy and practice regarding a very important aspect of human development, crucial for the vitality of society and civilization.

How Talent Development Research and Theory Sheds Light on Child and Adolescent Development and Beyond

Human potential and its fulfillment through development is a central issue for human development research. For that matter, developmental psychologists have wrestled with the nature-nurture conundrum for more than a century (see Sameroff, 2010). A great deal has been learned about how individuals create or master cultural tools and expressions, and develop and exercise their personal agency and creativity, regardless of whether we label it talent development or something else. To be sure, traditional research under the normative development assumption tends to direct their attention to when and how an "average" infant starts to crawl or walk, or when an "average" adolescent starts to have an "identity" issue, as if a precocious or developmentally challenged child does not warrant as much research attention. However, as we increasingly realize the centrality of developmental diversity in child and adolescent development, as argued by McCall (1981) and Wachs (2000), developmental niche, niche potential, niche valence, and talent trajectories, and for that matter, the power and limits of education and training (Bruner, 1996), and the opportunity structure presented in society (Merton, 1996), will become increasingly mainstreamed in developmental research. The significance of what is humanly possible through individual development and support of cultural artifacts and resources becomes more important in the age of technology capable of engineering some aspect of human development, blurring the nature-nurture distinction. Instead of a mere normative description of the putative "natural" course of ontogeny, more developmental insights can be gained by looking into how the biological and the cultural interact through proximal processes *in situ*, responsible for particular talent trajectories and pathways to human accomplishments essential for the survival and prosperity of the human kind.

Since Jean Piaget, there has been much research attempting to delineate competence development in the first 20 years of one's life. A central challenge is to integrate the two realms of developmental psychology (McCall, 1981) to show different patterns of individual development for different (groups of) children. Porath (2006) and her colleagues, for example, show that young children before 10 years of age already show domain-specific strengths (in math, art, and narrative) 2 years ahead of their age peers. They argued that children's "central conceptual structure", a term Case (2011) used to characterize pervasive cognitive structure developed in formative years, underlies the observed advanced level of domain-specific competence. How increasing differentiation and integration (Werner, 1967) takes place in formative years warrant much research so that talent development

phenomena can be firmly grounded in early domain-specific development. Advocates of relational developmental systems typically do not endorse a strong innate view of human competence. They show, for example, that even the development of motor movement, seemingly a matter of maturation, can be better characterized as a real-time adaptive process, rather than genetically programmed orderly progression (Thelen & Smith, 1994). How talent as a developmental novelty (e.g., exaptation) in various domains comes about remains to be explicated through a developmental systems lens; the dynamic self-organization of a developing person seems to hold the key to explaining structural and functional changes vis-à-vis task demands. Aside from the domain-specificity issue, dispositional factors such curiosity, or *delay of gratification* (Mischel, Shoda, & Rodriguez, 1989) are likely involved in regulating the development of exceptional competence.

Adolescence is characterized by increased autonomy and more opportunity to seek out environments (friends, books, domains of cultural activity). This is the basic assumption for the central role of characteristic adaptation (CA) in charting a particular course of action or line of development. Specifically, ECT postulates ease of learning, comparative advantage, and selective affinity (a good fit in the midst of many other options) as three tightly coupled developmental markers of CA, all indicating a pay-off of life choice. Studies of talented adolescents through experiential sampling show distinct patterns of CA in science and art (Csikszentmihalyi et al., 1993). Evolving Complexity Theory hypothesizes that both formal and informal learning across settings (see Barron, 2006) jointly produce a talent trajectory in terms of the exploration and carving of a personal action space (PAS) during adolescence.

A developmental systems approach reflects a new epistemology of child and adolescent development, finding different patterns of individual development rather than portraying an "average" normal development trajectory and pathway. It entails a contextualized approach to development that calls into question the traditional nomothetic assumption that child and adolescent development more or less follows the same path, sooner or later. Various phenomena of talent development represent developmental patterns that are distinctly individual rather than common to everyone (Feldman, 2003); they entail an understanding of evolving individuality that typically goes beyond the radarscope of traditional child and adolescent research, even when the focus is on developmental stability of "individual differences." Therefore, studies of structural, process, and temporal regularities of talent development need to select methods more reflectively and strategically. For example, the commonly used variable-centered, parametric method may be useful up to a point. Special care is needed to decide when a person-centered approach has to take the center stage (Laursen & Hoff, 2006; Magnusson, 2001). Moreover, a developmental systems approach takes a non-reductionist position on human development; that

is, a system's operation has its own logic or functional autonomy that is not reducible to lower-level components or operations. For example, the notion of probabilistic epigenesis suggests an interactionist or relational ontology of development (Gottlieb, 1998, 2007), rejecting the proposition that somehow genes determined developmental outcomes in a uni-directional, linear manner. A corollary of probabilistic epigenesis is that human development fits a non-linear or chaotic pattern, with multiple factors (person, place, time, and process) conspiring to produce a developmental trajectory, not unlike how a hurricane comes into existence. Thus, predicting child and adolescent development is just as tricky as, or trickier than, weather forecasting. Furthermore, probabilistic epigenesis also means that most developmental outcomes are equifinal and multifinal (Cicchetti & Rogosch, 1996). *Equifinality* refers to different initial conditions (be it genetic makeup or early experience) and/or different pathways leading to the same end state; *multiple finality* refers to the principle that how a component functions depend on how it relates to other components in a developmental system as well as the organization of the system as a whole. Talent development, given its social and developmental complexity, is likely to demonstrate equifinality and multifinality in a more powerful way than developmental psychopathology (Cicchetti & Rogosch, 1996). In this sense, developmental science, just like medical science or meteorology, is an inexact science, with many degrees of uncertainty and randomness inherently built into relevant phenomena. What comes to rescue, however, is that the structural, process, and temporal regularities of human development, as complex as talent development, can still be discerned and understood, and sources of complexities and uncertainties identified. Most importantly, the benefits of achieving such understanding and predictability, just like biomedical science or meteorology, are enormous for human welfare and prosperity.

Acknowledgments

This work was partly supported by a grant from Army Research Institute, Behavioral and Social Sciences, Grant No. W911NF-17-1-0236. Opinions expressed by the author here do not necessarily represent those of the funding agency.

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