Evolving Complexity Theory (ECT) of Talent Development:

A Developmental Systems Approach

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> The ontogenetic resolution of the nature-nurture debate may be that nature and nurture cooperate rather than compete, and that this cooperation is biased toward ontogenetic adaptation. James Baldwin (1895)

> Cognitive functions come into existence and differentiate due to the constant challenges and adaptation tasks that the social world entails…human cognition (including its highest form, creativity) is fundamentally culturally and symbolically mediated. Jaan Valsiner (1989)

Abstract

This article presents a new theory of talent development, Evolving Complexity Theory (ECT), in the context of the changing theoretical directions as well as landscape of gifted education. I argue that talent development provides a broader psychosocial basis for gifted and talented education than the concept of giftedness can afford. In this chapter, I first provide rationale for developing a developmental systems theory of talent development. I then discuss three essential dimensions of a developmental system and explicate how structural and functional changes in talent development (structural regularities) occur as the result of person-environmental interaction (process regularities) and are manifested as contextual-contextual emergence of new properties and new organizational principles. Finally, I discuss the policy and practical implications of ECT, and compare it with existing talent development models to demonstrate how a developmental systems theory can help solve some critical issues regarding the nature and nurture of human potential.

Evolving Complexity Theory (ECT) of Talent Development: A Developmental Systems Approach

Talent development is a theoretical movement in the field of giftedness and gifted education. It is not new and can be traced back as early as 1950s (e.g., Witty, 1958; see also Borland, 2014 on the Talented Youth Project in 1950s), but it is gaining momentum at the policy and practical level worldwide (e.g., The Talent Support model in Europe; Csermely, 2015). It poses challenges to a long-standing tradition in gifted education, the Gifted Child Paradigm (Dai, 2011, Dai & Chen, 2013; Subotnik, Olszewski-Kubilius, & Worrell, 2011). The ongoing "paradigm shift" is predicated on a profound change in how we understand human potential and ability. First, we no longer espouse a static, fixed capacity view of human potential in general and intelligence in particular. Instead, we now see human exceptional competence as diverse and pluralistic, dynamically shaped through developmental interaction with environmental opportunities and challenges (Dai, 2016). Second, we have gone beyond a purely cognitive view of "giftedness" in espousing a broader scope of what constitutes giftedness, encompassing a range of endogenous and exogenous forces (Dai & Renzulli, 2008). Talent development, in this sense, provides a broader psychosocial basis for gifted education than what the notion of "giftedness" can afford. Evolving Complexity Theory is developed in this context to provide a new theoretical model of talent development that reflects the above trend and can be used to guide educational policy and practice.

Motivation for a New Theory of Talent Development

More than ten years ago, I started to think of giftedness not as a static quality but as contextually bound, dynamically shaped through person-environment interaction, and temporally emergent (hence the Contextual, Emergent, Dynamic Model of Giftedness and Talent

Development (Dai & Renzulli, 2008), which I dubbed "giftedness in the making" (Dai, 2010, p. 196). At the core of this conceptualization is the assumption of exceptional competence as part of a relational developmental system, which is by nature interactive, dynamic, and complex (Overton, 2014; Molenaar, Lerner, & Newell, 2014). Over the years, my work has been guided by this developmental perspective, now better articulated as a developmental science framework (Cairns, Elder, & Costello, 1996) featuring prominently developmental systems theory. The result is a theory of talent development that specifies the process of talent development from its initially more or less nebulous state to an increasingly differentiated and integrated state with emergent new properties and organizational principles for its further development, a process that can best be described as that of *evolving complexity*, hence Evolving Complexity Theory (ECT; Dai, 2017).

There are strategic and methodological considerations for theorizing about talent development. We can use the traditional, reductionist approach, tracing development of exceptional human competence back to basic components, endogenous as well as exogenous (e.g., Gagné, 1985, 2005; Tannenbaum, 1983). However, a component theory, in its way of simplifying the realities, does not explicate how these components interact at the system level and how the developing system evolves over time as a whole (see Ziegler & Phillipson, 2012 for a critique). In addition, component models take a reductionist approach that lends itself easily to dichotomizing the role of nature and nurture, even polarizing debates on their respective role (e.g., Ericsson, Nandagopal, & Roring, 2007 vs. Gagné, 2009), when, as a matter of fact, nature and nurture never work alone developmentally without some interaction and reciprocation of each other (Gottlieb, 1998; Horowitz, 2000).

A developmental systems approach takes a more integrative approach to the nature-nurture problem: how nature is nurtured (i.e., epigenesis, bidirectional interaction; Gottlieb, 1998), how nurture reveals nature (e.g., gene-environment interactions and differential intervention outcomes; Baltes, 1998), and how nurture surpasses or transcends nature (e.g., structural and functional changes at neural, cognitive, and behavioral levels as a result of systematic training; Schlaug, 2001). The developmental systems approach treats *emergence* (i.e., the emergence of new structural and functional properties, including competence, through development) as a fundamental tenet of human development, avoiding any radical reductionist explanation of gifts and talents as static and genetically pre-determined (Dai, 2005). In short, a truly developmental theory of talent is by nature non-reductionist and organismic; that is, treating the organization of the person as a whole with higher-order organizational properties (e.g., increasingly purposive, self-directed behavior) and principles (e.g., adaptive value, cultural distinction) not reducible to lower-level components and operational rules. The notion of evolving complexity reflects this fundamental organization principle in human development. More specifically, ECT adheres to the following four tenets of dynamic systems (Lewis, 2000): (a) producing true novelty: new forms or structures (e.g., giftedness, talent, creativity) spontaneously appear; (b) becoming more complex (differentiated and integrated) over time, fine-tuned to environments and transformed via "proximal processes;" (c) going through phase transitions: new properties emerge, creating new dynamics and new levels of organized complexity, resulting in a more effective system; and (d) extrinsically sensitive (adaptive) and intrinsically robust (stable); thus talent development is indeterminate but principled.

How Evolving Complexity Theory (ECT)

Explicates Structural, Process, and Temporal Regularities

Originally conceptualized as contextual, emergent, and dynamic (Dai & Renzulli, 2008), talent development is cast in a three-dimensional conceptual framework shown in Figure 1.

Insert Figure 1 about here

The vertical dimension represents the person-environment interface, the horizontal dimension represents a life-span temporal progression, 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 the person is investigated and understood as a developing agent interacting with specific social-cultural contexts at a specific developmental juncture, with a particular timescale of the course of action. 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 environments (*process regularities,* specifying the developmental process of *how* some new properties emerge and develop) 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 1 (e.g., observations of proximal processes with time-intensive and relation-intensive methods; 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 demonstrating what humans can accomplish 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 1.

Structural Regularities: Talent as Structural and Functional Changes Indicative of Evolving Complexity of the Developing Person over Time

A major assumption underlying ECT 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. Developmental changes occur in a structurally predictable manner, "from a state of relative globality and lack of differentiation to a state of increasing differentiation, articulation, and hierarchical integration" (Werner, 1957, p.126). For ECT, this "increasing differentiation and hierarchical integration" is captured through a multi-level analytic framework presented in Figure 2, which shows how the evolving complexity of the developing person builds up through development (Dai, 2010).

Insert Figure 2 about here

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 chess, or early musical experiences). ECT identifies five basic functional domains of human activity: *expressive* (expressing oneself through imaginative play and artistic means, such as writing, drawing, acting, singing, dancing,), *technical* (making tools and gadgets to enhance effectiveness and efficiency), *intellectual* (reasoning, understanding, explaining, theorizing using mathematics, logic, visual-spatial imaging, or literary means), *social* (achieving practical purposes through effective communication, negotiation, collaboration, and leadership), and *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). These foundational effectivities help human beings survive and thrive, and thus hold a fundamental adaptive value. Aptitudes and dispositions facilitate development of effectivities in these foundational domains. Thus we might identify a child or adolescent's profile of aptitudes and dispositions vis-à-vis affordances and constraints of a wide range of cultural activities, including but not confined to formal education (Lohman, 2005). ECT also identifies aptitudes that mainly exert regulatory power, similar to metacomponent in the triarchic theory of intelligence (Sternberg, 1985). For example, one exercises metacognitive control to backtrack and fine-tune one's performance (Feltovich, Prietula, & Ericsson, 2006). In addition, dispositions refer to a set of "nonintellective" personal characteristics that have action potency, such as openness to experience, curiosity, passion, conscientiousness, and perseverance, which have a direct bearing on developmental potential.

A particular profile of aptitudes and dispositions can be conducive to a science or art career trajectory (Feist, 2006; Lubinski, 2010). However, one can develop many "effectivities" that are discrete: differentiated and not integrated. It is *characteristic adaptation* (CA), that is, characteristic ways the person seeks certain developmental opportunities to carves out a distinct

developmental niche (Wach, 2000) that dynamically shapes the self-organization of effectivities into a talent trajectory in cultural domains (Csikszentmihalyi, 1996). In other words, CA represents a higher-level self-organization of personal adaptation compared to the first-order personal properties reflected in 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 mathematical, verbal, and spatial abilities (e.g., Wai et al., 2009), coupled with distinct interests (Lubinski & Benbow, 2006). Characteristic adaptation is 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.

Beyond CA in development, 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 the emergence of *maximal adaptation* (MA) to certain task environments, as compared to the more situational, spontaneous, self-organized (bottom-up) nature of *CA*. 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).

The notion of *construction of self and future* highlights the functional significance of maintaining a particular line of personal undertaking regardless of how facilitative or adverse situational conditions may be.

Finally, at Level IV, as shown in Figure 2, is the most inclusive level of analysis. It is all-encompassing in the sense that all Levels I-III structural and functional changes can be understood in a broader context to reveal the social-cultural mediation of these developmental changes (Valsiner, 1989). As the two arrows indicate, as the developing person makes adaptive efforts vis-à-vis developmental opportunities and challenges, the cultural meaning and significance of a particular personal endeavor is increasingly integrated into the core of his or her individuality. Together, this four-level analytic framework reveals the main endogenous and exogenous forces propelling the development of individuality, of which talent is just a manifestation.

Structural regularities defined as increasing differentiation and integration have an external 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 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 opportunities and choices; some become regional major players, and others international-caliber players. In addition, structural regularities, indicative of structural and functional changes that can be qualitative as well as quantitative, also highlight 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., the difference found is a matter of degree). However, when cumulative changes in advantages and inclinations build up to a critical point, not only intra-personal developmental discontinuity takes place (hence phase transition); inter-individual differences in talent become a matter of kind (see Dai, 2010, Chapter 4 for detailed discussion). Implications of such developmental changes are profound 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 (hence, its domain-specificity; Feltovich et al., 2006).

In sum, *structural regularities* specify the nature of evolving complexity through increasing differentiation and integration; it elucidates the nature of talent in the context of individual development. More specifically, structural regularities help delineate diverse patterns of developmental changes in behavioral, cognitive, and psychosocial functions indicative of niche potential and talent trajectories and pathways that are discernable in cross-sectional and longitudinal data. What leads to these structural and functional changes in real-time transactional interaction between the developing person and dynamic environments? Evolving Complexity Theory postulate specific psychosocial mechanisms underlying CA and the transition to MA.

Process Regularities: Interactive Cognitive, Affective-Conative, and Social Processes Undergirding Characteristic and Maximal Adaptation

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 *biologically secondary* (Geary, 1995); that is, they are not innately built into, or hard-wired

through, our genetic codes. In order to understanding the genesis of talent as well as specific talent trajectories and pathways, talent-related developmental changes have to be situated in social-cultural contexts, and understood as *contextually emergent* through real time person-environment interaction, 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)

Accordingly, ECT uses a push-sustain metaphor to characterize mechanisms underlying the developing person's transactional experiences that propels talent development (Figure 3). The arrow represents the developing person, with all his or her endogenous power, interacting with two kinds of exogenous forces: environmental press (opportunities and challenges) on the one hand, and sociocultural support (resources, tools, and values) on the other. That ECT starts with "environmental press," rather than with a "talent" or "gift," distinguishes itself from trait theories of gifts and talents (e.g., Gagné, 2005). *Environmental press* refers to a situation that evokes a need within the organism that has adaptive consequences (Murray, 1938). To use the language of ecological psychology, environmental press *affords* certain opportunities to learn, to develop, to control, to enjoy, to achieve certain personal ambitions; at the same time, however, it sets constraints and conditions (i.e., challenges) that need to be met in order to materialize the affordances in question. The nature of such person-environmental transaction determines, first and foremost, that a talent is not innate (e.g., there is not a set of genes dedicated to music) but the result of self-organized, self-directed adaptive responses to environmental opportunities and

challenges. I use the "push-sustain" metaphor to denote this need-evoking, action-sustaining process.

Insert Figure 3 about here

As a first approximation, ECT assumes that individuals in their life time go through a progressive course of learning and talent development experiences, in the order of informal learning experiences (e.g., those facilitated at home or initiated by oneself) followed by formal education, advanced training, and ultimately cutting-edge work in particular domains. We can roughly view the long-term process of talent development as characterized by the emergence of CA, followed by a graduate transition to MA. This is not to say that MA does not exist in early phases of development. Rather, as well established in both the personality and educational psychology literature, in loosely structured environments typical in early stages of human development, developing persons tend to follow their own "agendas" and pursue their own interests while interacting with formal and informal learning environments (see the arrow indicating one's CA in Figure 2). As a result, individual differences in CA are more likely to show through (Buss, 1989; Ackerman, 2013). In contrast, MA is the norm in regimented cultural environments characterizing most advanced training and development, and all professional work (as suggested by the backward arrow in Figure 2). The turning point from CA to MA is a change from avocational interests and vocational commitments. To further specify the developmental process in terms of the emergence of CA and MA, ECT postulates four phases of talent development. To use music for illustration, demonstrating music-related aptitudes and dispositions (Foundational Phase) is one thing, and pursuing a musical interest (Transitional Phase) is another; becoming a musician (Crystallizing Phase) is one thing, and sustained effort to

perfect one's music skills and exploring a new form or personal style of musical expression (Advanced Phase) is another (Subotnik & Jarvin, 2005). The game changes, so to speak, as the person moves to a later phase of talent development. Table 1 shows different developmental tasks involved, affect (endogenous) and social conditions and expectations (exogenous) that sustain these tasks. For ECT, the development of effectivities in foundational domains through self-organization of aptitudes and dispositions in formative years (Phase 1) prepares one for CA (Phase 2), and the development of identity and commitment through construction of self and future (Phase 3) discussed earlier (Figure 2) leads to a phase transition to MA (Phase 4). Of the central importance to ECT is what drives the emergence of CA and the transition to MA, respectively.

Insert Table 1 about here

The push-sustain mechanisms for CA and MA For CA, are quite different. For CA, the push comes from the development of autonomy and the adaptive pressure of "niche picking," and increasing cultural expectations for individual competence and effectiveness. What underlies CA endogenously is a set of cognitive, affective-conative, and social factors: *ease of learning*, *comparative advantage*, and *selective affinity* that indicates the overall goodness of fit with a particular task and social environment. To be sure, signs of such fit could be shown in formative years, but the mind of a developing child is not well differentiated and integrated in the Foundational Phase; what sustains CA exogenously is a set of facilitative and supporting factors or the opportunity structure that favor specific selections of course of action or development. In contrast, for MA, the push comes from increasingly task challenges and cognitive demands, for which even having "natural talent" is not sufficient. It also comes, more socially, from cultural

and institutional expectations for excellence and rigor. What prompts and sustains MA is the development of identity and commitment (Dai et al., 2015) in Crystalizing Phase) and dedicated effort for self-improvement (staying at the edge of chaos; Dai & Renzulli, 2008) endogenously, and often indispensable pedagogical, technical, and institutional support exogenously. Give the complex interaction of these endogenous and exogenous factors, ECT is a distinct interaction-dominant rather than component-dominant model of talent development (Hilpert & Marchand, 2018), as it sees talent development as involving a *relational developmental system* with interacting components (cognitive, affective-conative, and social), and new emergent properties and organizational principles (CA and MA) at a system level, irreducible to lower-level explanations (i.e., lower-level components and operations).

Temporal Regularities: The Timing and Duration of Transactional Experiences Critical for Optimal Talent Development

Structural and process regularities in talent development are always intertwined with the issue of timing and duration of specific developmental changes involved. For example, structurally, hierarchical integration in terms of emergent CA cannot occur very early when a child does not gain sufficient autonomy psychologically and socially to seek out developmental opportunities or choose a particular course of action, no matter how "talented" he or she is. By the same token, the duration of specific *proximal processes* may be essential to sustain a line of talent development or it will discontinue for life. Temporal regularities, thus, refer to specific developmental timing and duration of structural and functional changes or developmental processes important for optimal talent development, even critical as a make-or-break issue.

First, the developmental timing of the onset of talent development (and thus exposure) matters. For ECT, a critical task is to define the developmental timing of the onset of CA and

MA, and the 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. My own research (Dai & Li, under review) show that early college entrance to a STEM program led to an accelerated rate of talent progression and career accomplishments for some top students; roughly a three-year acceleration (ahead of peers in entry to college) in the Transitional Phase translates into a ten-year advantage in the Advanced Phase in terms of achieving milestone social recognition (e.g., NSF CAREER award), a distinct Matthew Effect, largely due to early transition to MA (the new level of dedicated effort and the institutional rigor, resources, and support (see Merton, 1996). ECT postulates several domain-related factors determining the timing issue (performance vs. productivity, technicality, the threshold requirement of social maturity, etc.)

Insert Figure 4 about here

In addition to the timing of onset, the duration of proximal processes in all phases of talent development matters with respect to the timing of peak performance or productivity, largely because talent development is a survival game. As most untenured faculty members know, maintaining a talent trajectory is of paramount importance up to the date when the tenure decision is to be made. By the same token, whether an athlete maintains a competitive edge at the state level may determine whether one has a chance to make it to Olympic games. In the expertise literature, there is a well documented "10-year rule" (Simon & Chase, 1973; Ericsson, 2006); that is, it takes roughly ten 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. Although the 10-year

rule is recently disputed (Hambrick, Burgoyne, Macnamara, & Ullen, 2018), talent development in the advanced phase entails more staying power and persistence.

The issue of meeting institutional expectations may be less critical for young learners, but MA can still viable to those school-age individuals when their level of knowledge and skills are sophisticated enough for engaging in advanced, cutting-edge work, such as conducting an innovative research project while still in high school, inventing valuable products and procedures, or reaching a high level of performance in music by adult professional standards while still while still a teenager.

Sum-Up

In sum, structural, process, and temporal regularities (the issue of what, how, and when) postulated by ECT help explicate talent development in an integrated way. It postulates *when* specific talent will likely emerge with exposure and experience, and *how likely it will endure* (*temporal regularities*), and how likely related structural and functional changes (*structural regularities)* under the manifestation of talent will occur given the timing and duration of specific transactional experiences or proximal processes (process regularities). Together, they constitute the essence of evolving complexity involved in talent development. From a developmental science point of view, it is a unified theory of talent development grounded in many lines of research (e.g., on talent, motivation, expertise, and creativity). Because of the developmental synthesis, talent development in a variety of domains, from highly regimented to loosely structured settings, can be mapped out.

II. What Distinguishes ETT from Other Talent Development Models

In a nutshell, ECT postulates talent development as contextually engendered, rather than innate, dynamically shaped through person-environmental transactional experiences, and

temporally evolving and going through phase transitions through increasing differentiation and hierarchical integration (hence, evolving complexity). Two main patterns of adaptive behaviors, CA and MA, regulate this developmental process, responsible for development of high-caliber performance and creative productivity. In ECT, how biology and culture, nature and nurture, the endogenous and exogenous, work together to advance talent and creative productivity is explicated as an evolving process of adaptation with increasing organized complexity.

They can be roughly divided into two kinds: component models by and large based on psychometric, long-range prediction studies (Simonton, 2005; Lubinski & Benbow, 2006; Feist, 1998, 2006; Gagné, 2005), and process models, typically based on more up-close investigation of the person in context and developmental processes (Gruber, 1986; Feldman, 1986; Csikszentmihalyi et al., 1993; Bloom, 1985; Subotnik et al., 2011, 2012; Plucker & Barab, 2005). Renzulli's (1986) three-ring theory is in essence a process theory (e.g., how task commitment and creativity are contextually and developmentally shaped), but presented as a trait model based on prediction studies (see Renzulli, 1978). What distinguishes ECT from the existing models of talent development is that it is a process theory (specifying what, and how, and when of talent development) that simultaneously accounts for talent distributions and trajectories, which is of primary focus for the component models.

ECT is guided by relational developmental systems theory (Overton, 2014), according to which both micro-level and macro level development can be captured when a multi-level integration is made across different lines of research (Cairns et al., 1996). Such integration allows ECT to integrate a model of differential development (structural regularities) and developmental processes accounts of these changes (process regularities) with timing of onset and timescale in mind (temporal regularities). As a result, the theory is capable of covering a

broader range of empirical observations than either a component account or a process account can, thus avoiding the problems of having two disciplines or realms of psychology (Cronbach, 1957; McCall, 1981).

Moreover, existing talent development models, whether of the component or process variety, tend to remain implicit regarding increasing differentiation and hierarchical integration involved as well as the underlying forces driving developmental processes and transitions to a new level of evolving complexity occurs. When this happens, development (i.e., what develops, and how and when) remains a default, implicit assumption, not subject to empirical observation (see Sternberg & Davidson, 1986 for a distinction between implicit and explicit theoretical models). ECT specifies emergence of new properties and organization principles at multiple levels at different developmental junctures, showing how push-sustain mechanisms every step of the way through cognitive, affective-conative, and social forces that propel further developmental changes. The articulation of these structural and process regularities (i.e., explicitness) by ECT can potentially enhance higher sensitivity of developmental assessment and more specificity in formulating research hypotheses as well as designing targeted interventions.

Finally ECT is a distinct effort to integrate talent development research and theory into a more broadly defined science of human development in that it uses talent development as a window through which to discover the nature and nurture of human potential, and treat the development of high-caliber performance and creative productivity as epitomizing the highest form of human development. It shows the adaptive nature of human development and the primacy of human activity in development; it highlights of the nature of human adaptivity as involving the biological tendency to seek the best person-environment fit with characteristic

adaptation (CA) as well as the cultural tendency toward maximal adaptation (MA) for its own collective agenda with its tools and resources.

III. ECT as a Guiding Tool for Practice

As I argue elsewhere, gifted education in the United States has inherited the legacy of what I call the "*Gifted Child Paradigm*" (Dai, 2011; Dai & Chen, 2013), which is predicated on the assumption of bifurcation between the gifted and non-gifted, as if they are two different categories of people (see Borland, 2003, 2005 for a critique). Historically, the notion of giftedness was closely associated high IQ (Dai, 2018). Granted that IQ can be one indicator of developmental potential, there are many other factors, such as various talents, motivation, personality characteristics, and symbol systems and cultural tools, that underlie what one can become. Therefore, if the purpose of gifted education is to cultivate human potential to the highest level humanly possible, an exclusive focus on IQ is vastly inadequate, given our understanding of the pluralistic and developmental nature of human potential. ECT (Dai, 2017) is intended to be truly a systems theory of talent development that can help facilitate a paradigm shift in gifted and talent education, to make it scientifically more compelling, socially more equitable, and educationally more productive (Dai, 2016).

A distinct advantage of ECT (particularly over component models) is that by explicating the dynamic interplay of endogenous and exogenous forces interacting in shaping talent trajectories and pathways every step of the way, it can be easily applied in educational and training settings, with interventions designed according to its theory-based principles and guidelines (see Table 1).

Policy Implications of ECT

The overarching principle derived from ECT is to make the education system more open and adaptive to developmental diversity, encouraging maximal participation in a diverse range of talent development opportunities promoting excellence as one of the core values for students. Cultivation of developmental potential, rather than "serving the gifted," should become the main impetus of educational provisions. This way, gifted and talented education and regular education are just a division of labor, not two separate education systems. When excellence in culturally valued domains (including but not limited to academics) becomes a priority for a school, gifted and talented education will be prominent featured, regardless of how it is labeled. The following strategies will help improve education practice:

Aligning Education with Developmental Trajectories

A main assumption of ECT is that individual characteristic adaptations (CA) can be harnessed to maximize its developmental outcomes (i.e., optimal development). In this regard, structural regularities (emergent CA, personal interests and strivings, etc.) help educators identify important developmental changes and divergent developmental patterns among students that are conducive to particular lines of talent development. Understanding of developmental continuity and discontinuity (i.e., the onset of puberty) can facilitate a developmentally responsive education (Dai, 2010). As ECT considers education as integral part of human development (with its pedagogical tools and social-cultural support), educators can be more proactive in creating talent development agendas, rather than merely react to signs of talent. For that matter, how to facilitate basic human effectivities in formative years, and identify aptitudes and dispositions along the way, and how to facilitate and identify CA, and how to facilitate transition to MA through affective development, become a main education challenge. For example, early enrichment activities in targeted domains of talent can be extremely helpful for exposure,

threshold experiences, and development of early interests. In this regard, informal learning across home, community, and school can be highly valuable for the emergence of CA and identity (Barron, 2006). Although it is difficult for educators to have a total control over the timing and duration of relevant proximal processes necessary to advance particular lines of talent development, educators should be more alert to the role of timely opportunities and sustainability of lines of talent work. For that matter, temporal regularizes stipulated by ECT as optimal for various domains can help optimize individual talent development through timely provision of structured experience, formal learning, and training. A relevant example is the accelerated pace of academic progression and early onset of advanced learning in STEM fields. Feldhusen (2003) argued that gifted education provisions be better conceptualized as *programming* for individual development rather than providing *programs*, which tend to take a short-term, piecemeal approach without concerns for long-term development. As a developmental process theory, ECT can guide such programming.

Identification as Developmental Prognosis, not a Status Determination

It has been long argued that identification and intervention should be tightly coupled (i.e., directly tied to educational needs; Callahan, 1996; Tomlinson, 2014). However, most models of talent development do not explicate developmental processes and transitions in a way that can guide identification. In this regard, ECT permits a phase- and stage-sensitive identification; that is, identification is no longer made of a fixed formula, administered in a once-and-for-all fashion, but as a prognosis of the person's possible future advances based on demonstrated strengths and interests and personality characteristics. In other words, developmental trajectories can be cast in a developmental corridor and mapped out for intervention purposes. Even some milestone events can be predicted in a developmental pathway to excellence. The role of teachers for sheparding

the process becomes crucial. For example, a talent portfolio will help teachers and counselors keep track of a student's progress along a particular talent trajectory or pathway.

Facilitating Transition from MA to CA as the Main Task of Gifted Education

Because ECT is a developmental theory, it affords a clearer idea of when to do what. For example, it postulates that impetus for the transition to MA is that CA can hit its plateau or bottleneck (when left to one's own devices) unless a more rigorous regiment of learning and training is put in place. This issue is more likely to occur during adolescence. Conceptualized this way, the challenge of gifted and talented education (e.g., required research projects for high school students, as practiced in specialized STEM schools) is a timely provision to help adolescents stretch their limits through maximal adaptation to challenges at hand (e.g., a robot competition, a project of solving a local pollution problem).

Counseling for Optimal Development

Talented children and adolescents have additional counseling needs precisely because they have increasingly tough challenges to face and more hurdles to overcome in individual development if they were to survive and thrive on particular lines of talent development. Evolving complexity for them implies that by living on the edge, so to speak, developmental instability is more common for them (Dai & Renzulli, 2008). Throughout the four developmental phases, self-development is always crucial (even for athletes as young as 10 years old). ECT provide guidance as to what counseling and guidance should focus on for each phase of talent development. For example, ECT postulates that adolescence is the best window for encouraging exploration and expansion of personal action space (PAS). Counseling can help talented teenagers to clarify their interests and aspirations, encourage them to explore areas that they may

otherwise hesitate to. For another, according to ECT, a main endogenous barrier for transition to MA is affective in nature: identity (personal vision) and commitment to a particular line of work. Counseling and guidance has a lot to do in recognizing talented students' strengths and accomplishments, helping them cope with stress and self-related issues, and envision their life trajectories and possibilities.

Discussion Questions:

• What are major advantages of interaction-dominant models over component-dominant models of giftedness and talent?

• In what way does ECT help us rethink the nature and development of human potential?

• Why is an emphasis on contextual and temporal emergence of structural and functional changes a fundamental rejection of reductionism in talent development theory and research? In what way does it help avoid falling into the trap of the nature-nurture dichotomy?

• In what ways does ECT change the way we think about the practice of gifted and talent education, especially the means and ends of identification and intervention?

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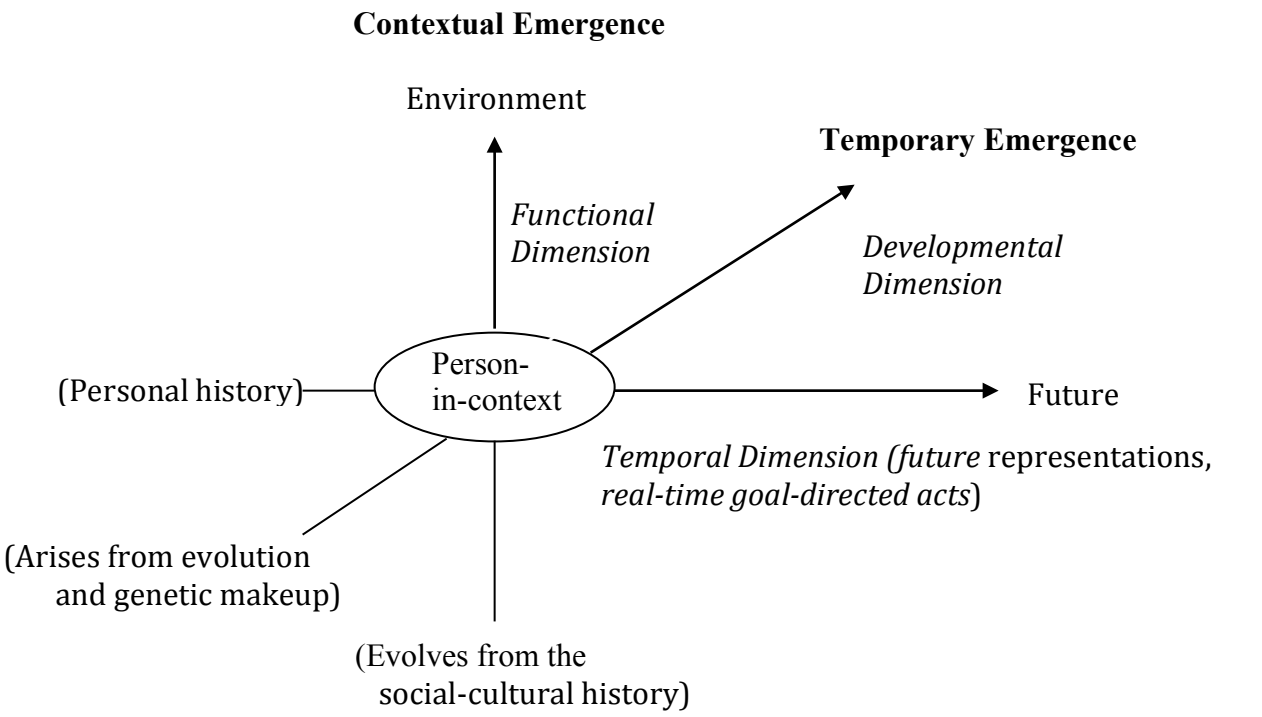

Figure 1. *A schematic representation of three critical dimensions of human functioning and development*. The oval indicates a unit of analysis that intersects the three dimensions. The arrows signify the dynamic nature and directionality of the three dimensions (originally published in Dai & Renzulli, 2008)

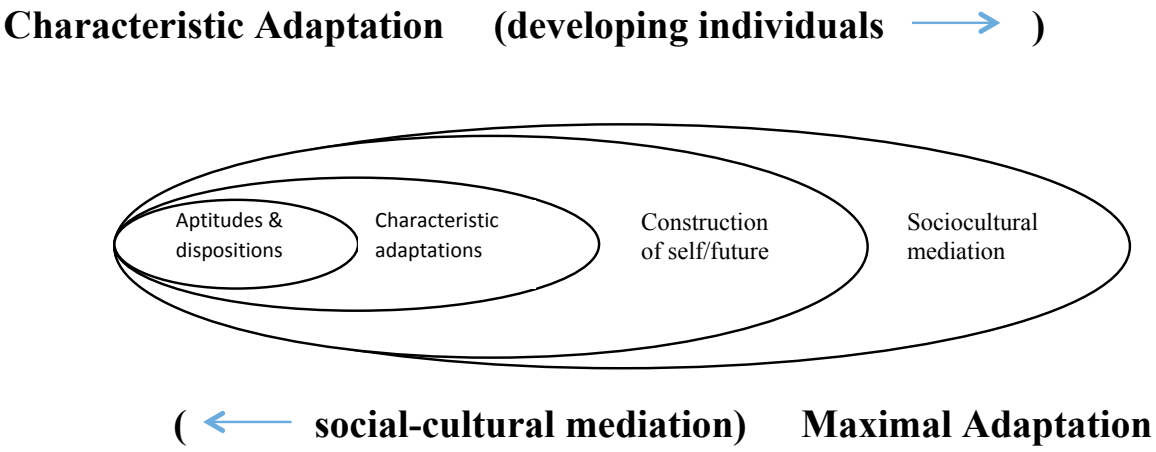

Figure 2. The developing person driven by both endogenous and exogenous forces from a multi-level analytic point of view (adapted from Dai, 2010).

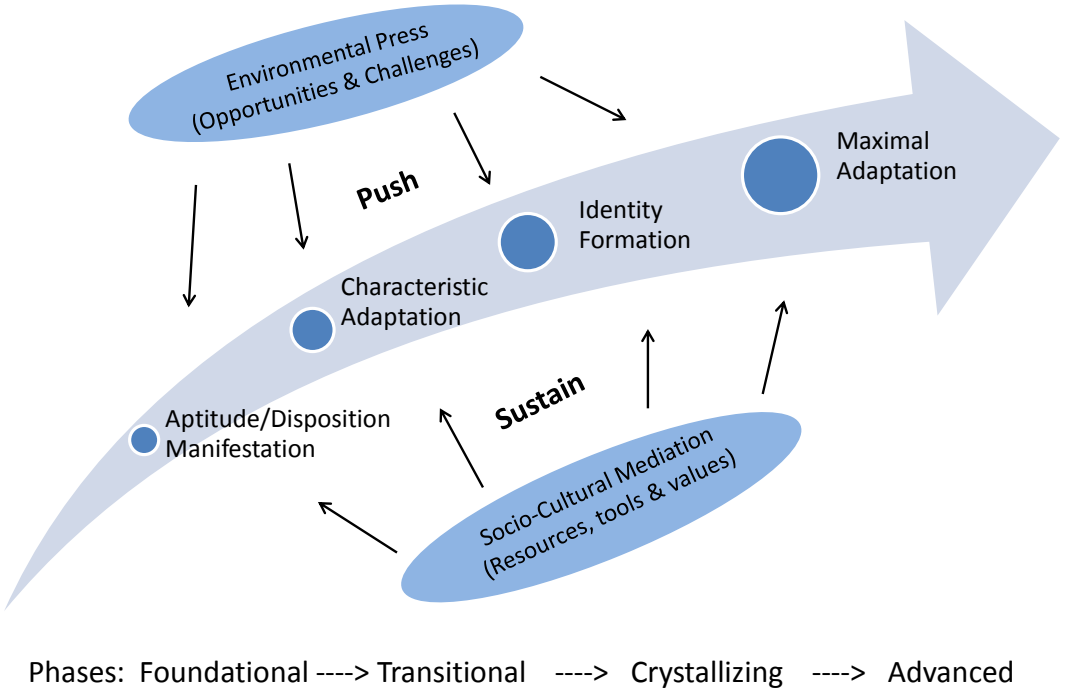

Figure 3. A schematic representation of Evolving Complexity Theory of talent development.

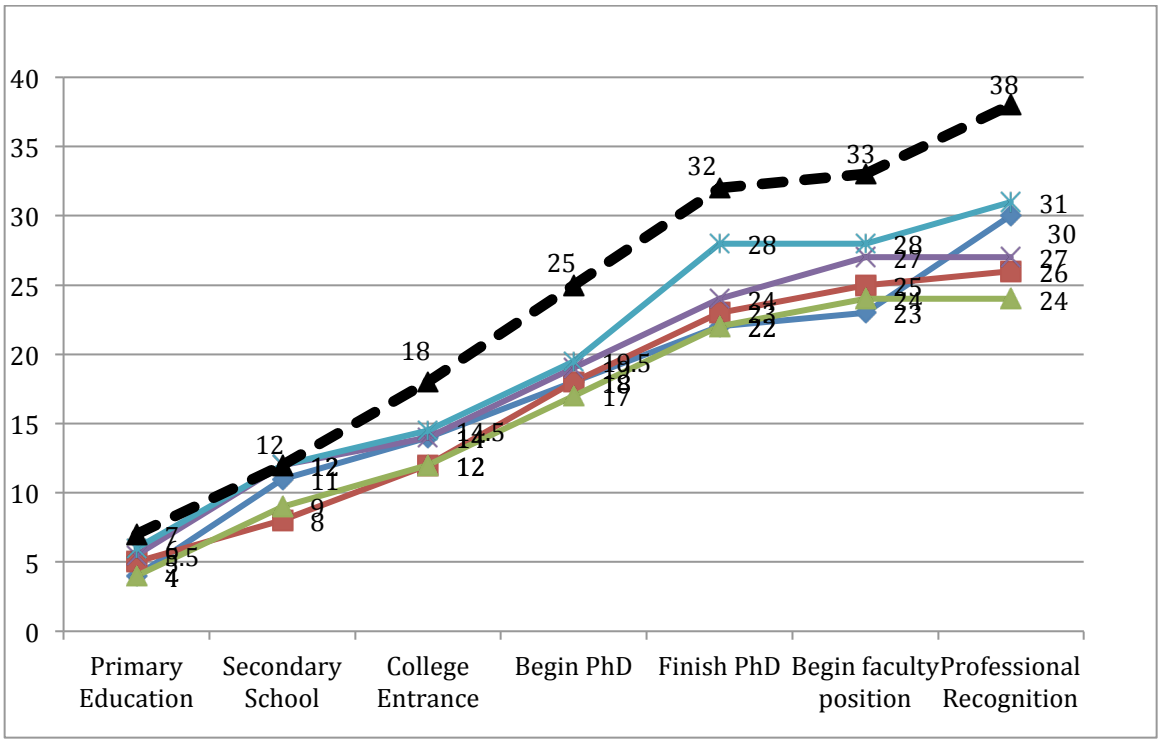

Figure 4. The plotting of five cases of an accelerated career trajectory for professional recognition. Note: The dotted line indicates an average trajectory of talent development in STEM based on US national statistics.