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Evolving Complexity Theory (ECT) of Talent Development: A New Vision for Gifted and Talented Education

David Yun Dai

A major problem in the history of conceptualizing giftedness or talent is that of *reification*: we treated giftedness or talent as a thing residing in our brain, like a Japanese origami, only to be uncovered once and for all, be it high IQs or scores on other aptitude tests. Today we still need to wrestle with the question Renzulli (1986) raised decades ago: "Is giftedness an absolute or a relative concept? That is, is a person either gifted or not gifted (the absolute view) or can varying kinds and degrees of gifted behaviors be displayed in certain people, at certain times, and under certain circumstances (the relative view)?" (p. 62).

Consider two hypothetical cases: Jen is a 10-year-old who shows a distinct penchant for mathematics and whose IQ score puts her in the "gifted" range, and Joe is a 16-year-old who does not show academic excellence in school grades but seems "talented" in creative writing. Jen is apparently gifted, but who can say Joe is less "gifted" or is just "talented?" When we take a "relative view" of giftedness and talent, the contexts in which Jen and Joe live and work become important, so do the developmental timing and duration of relevant exposure, and experience relative to their specific talent domains (Dai & Renzulli, 2008). I dubbed this more contextual, dynamic, emergent perspective, "giftedness in the making" (Dai, 2010, p. 196). In essence, giftedness or

D. Y. Dai (✉)
University at Albany, State University of New York, Albany, NY, USA
e-mail: ydai@albany.edu

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talent, however defined, is treated as an emergent property of a relational developmental system (Overton, 2014).

More formally, I present this system in terms of a three-dimensional framework shown in Fig. 7.1. The vertical axis represents the person-environment interface, the horizontal axis represents a life-span temporal progression, and the diagonal axis represents structural and functional changes of the developing person over time. In essence, talent development in terms of the increasingly differentiated and integrated competence and increasingly purposive personhood (i.e., individuality), represented by the diagonal line, are *contextually and temporally emergent* from the person-environment transactions (vertical line) over time (horizontal line). The intersection of the three dimensions forms a basic *unit of analysis*: person-in-place/time. The person is investigated and understood as a *developing agent* interacting with a specific social-cultural environment at a specific developmental juncture, with a particular timescale of transactions specific to the developmental changes in question (Bronfenbrenner, 1989; Cairns, Elder, & Costello, 1996). When applied to the example discussed above, the unit of analysis should be such that Jen's flair for math or Joe's interest in creative writing should be situated in context and dynamically understood.

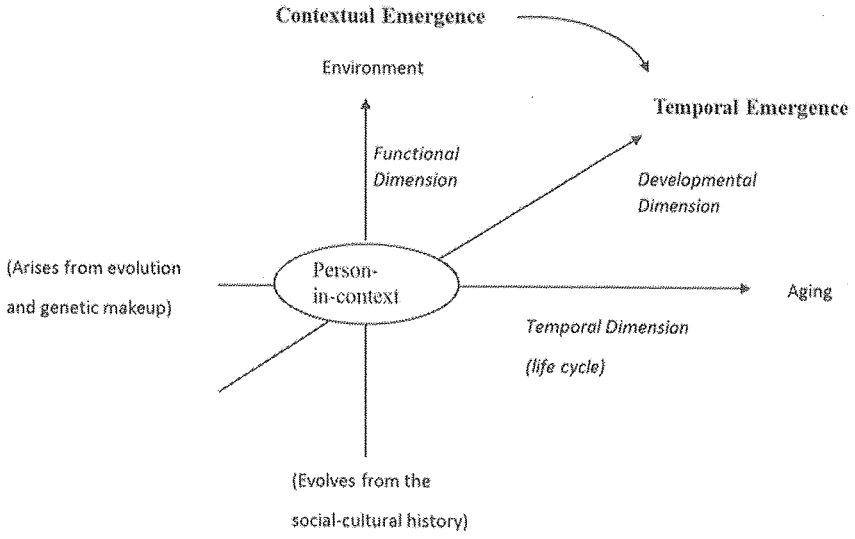

Fig. 7.1 A schematic representation of a dynamic, relational developmental system with three main dimensions: *functional* (the vertical dimension: person-environment transactions), *temporal* (the horizontal dimension: a person's life trajectory toward maturity and aging), and *developmental* (the diagonal dimension: a joint function of the functional and temporal emergence of new properties)

Evolving Complexity Theory (ECT): A Long Argument

Now that the stage is set, how do we characterize this relational developmental system of which giftedness or talent are emergent properties or manifestations? Kenneth Libbrecht (2004), a Caltech physics professor, described how snowflakes take shape: "Growth is the key ingredient for the generation of snow-crystal patterns. . . Even the tiniest protruding points will grow faster than their surroundings and thus protrude even more. Small corners grow into branches; random bumps on the branches grow into sidebranches. *Complexity is born* [italics added]" (p. 25).

The emergence of giftedness or talent is similar to snow-crystal formation, except that it involves *a developing person (a Jen or Joe), who is undergoing changes in oneself in multiple ways at multiple levels while interacting with the environment and exercising its agency* (Dai & Renzulli, 2008; Gottlieb, 1998, 2007). Lewis (2000) viewed the developing person as an open, dynamic, and adaptive living system that shows the following tenets: (a) producing novelty, (b) becoming ever more complex, (c) undergoing phase transitions, and (d) intrinsically robust to maintain its own continuity and extrinsically sensitive and adaptive to the environment. Dynamic system theory provides a foundation for conceptualizing giftedness and talent development as following the same developmental principle of evolving complexity, hence Evolving Complexity Theory (ECT, Dai, 2017).

The Contextual and Developmental Nature of Human Potential

The main assumption of ECT is that a truly developmental theory of talent is by nature organismic and non-reductionist. That is, the self-organization of the person as a whole has novel organizational properties, for example, increasingly differentiated and integrated functions, and increasingly purposive, self-directed behavior, which cannot be reduced to lower-level components (e.g., capacity and genetics). Also, individual developing follows self-organization principles (e.g., maximizing niche potential and seeking cultural distinction) that are not reducible to lower-level operational rules (e.g., self-preservation). The notion of *evolving complexity* reflects this fundamental principle of human development in general, and talent development in particular.

Through this lens, one can define talent development as *a prolonged process of human adaptation resulting in outstanding human accomplishments.* These

accomplishments may stretch human limits in terms of extraordinary skilled performance (e.g., in sports, performing arts, and vocational professions), or take the form of creative contributions that significantly improve human conditions (e.g., philosophy, science, technology, literature, and art; cf. Sternberg, 2019). Hence,

Proposition 1 *Talent is a structural and functional property of the person relative to context and time. Talent emerges contextually and temporarily through maturation and adaptive transactions with relevant social-cultural environments. Talent development thus shows ever evolving complexity that cannot be "explained away" by lower-level simpler components that are part of the developmental system in question.*

Talent Potential as Dynamic and Variable

In contrast to the reductionistic bifurcation of nature and nurture as two separate forces contributing additively to human development, ECT views human potential as coming neither from nature nor from nurture alone. In this sense, human potential is not a *genetic constant* determined at birth or even conception, only to be "unleashed" to some degree depending on environmental opportunities and resources (i.e., a *reaction range* model; see Bouchard, 1997). Rather, human potential is a developmentally changing variable that depends on the nature of person-environment transactions, as well as the timing and duration of these transactions. Hence,

Proposition 2 *A person's talent potential is not a fixed capacity but depends on the person's environmental opportunities, resources, and transactional experiences* (i.e., *proximal processes;* Bronfenbrenner & Ceci, 1994). *Therefore, talent potential is dynamically evolving through probabilistic epigenesis* (Gottlieb, 1998) *and contingent on extended learning (formal or informal) and productive experiences that reciprocate with one's biological system* (e.g., *aptitudes and dispositions) at specific developmental junctures.*

The above proposition sets ECT apart from the pro-nature or "being" argument (Gagné, 2009) that an individual must be "gifted" in order to subsequently be talented. It also distinguishes ECT from the pro-nurture or "doing" argument (Ericsson, Krampe, & Tesch-Romer, 1993; Ericsson, Nandagopal, & Roring, 2007) that natural endowment (except for the predisposition to work hard) is negligible, as the nature-nurture bidirectional influence includes

the role of genetics and biologically constitutional properties (Gottlieb, 1998; Horowitz, 2000). According to Propositions 7.1 and 7.2, a theory of talent development needs to address three empirical questions:

A) *What* develops (emergent structural and functional properties, increasing differentiation and integration of these functions, increasing self-directedness), which is addressed in Propositions 7.3 and 7.4.
B) *How* these changes occur at every step of the way (regulatory processes, endogenous or exogenous, that sustain actions, leading to structural and functional changes undergirding the manifest talent), which is addressed by Propositions 7.5 and 7.6.
C) *When* developmental transactions take place, and for how long the transactions must occur to effect a developmental change (see the curved arrow from contextual to temporal emergence in Fig. 7.1), which is addressed by Propositions 7.7 and 7.8.

Theoretical postulations in response to these three empirical questions (What, How, and When/How Long) will be delineated in the following sections, based on the preponderance of research evidence.

Structural and Functional Changes from Bio-ecological Effectivity to Talent

The contextual and temporal emergence of effectivity and talent is the central focus of ECT. ECT postulates five basic forms of bio-ecological effectivity: (1) *psychomotor* (executing and coordinating body movements to accomplish complex goals), (2) *social* (achieving practical goals in social situations through effective communication, negotiation, collaboration, and leadership), (3) *expressive* (expressing feelings and desires through imaginative play and artistic means, such as writing, drawing, acting, singing, dancing), (4) *technical* (making tools, gadgets, and codes to enhance effectiveness and efficiency), and (5) *intellectual* (observing, reasoning, experimenting, modeling, explaining, and theorizing using mathematics and logic, visual-spatial imaging, or literary means). Imagine that, in the hunter-gathering age, these five forms of bio-ecological effectivity were already at play for survival and reproduction (see Ziegler, 2005). In modern times, these basic forms of effectivity are just camouflaged in a variety of cultural and educational activities (e.g., sports, debates, science projects). In this sense, an *effectivity* (e.g., artistic expressiveness) is *biologically primary* (Geary, 1995) and can be demonstrated in informal,

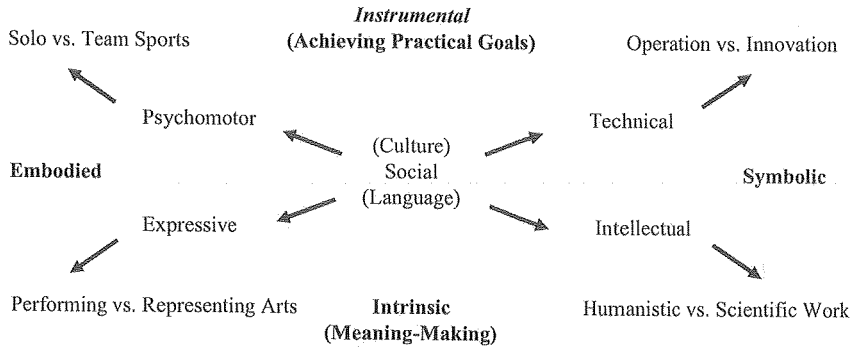

Fig. 7.2 A representation of structural and functional changes in *human effectivity* in five foundational domains, further differentiated (refined) and integrated with learning experiences in various cultural domains

"naturalistic" settings. In contrast, *talent* in the ECT nomenclature refers to high proficiency in culturally created domains or institutionalized social practice, typically involving culturally and semantically rich symbol systems (Csikszentmihalyi & Robinson, 1986). Therefore, talent involves more specialized skills and proficiencies (piano playing) that are *biologically secondary* and culture-dependent.

Figure 7.2 shows how increasing differentiation plays out developmentally. ECT postulates that five forms of effectivity are developed and manifested in early formative years through direct experience (e.g., at home or with peers) as well as significant social-cultural mediation (e.g., schooling). At the center is development of social effectivity, largely facilitated by social interaction and language skills. Thus, the developing person can be seen as socially situated, with a proverbial radarscope (specific sensitivity or proclivity) constantly scanning various environmental opportunities for self-development. In the meantime, specific effectivity also likely draws attentions from adults and enjoys differential cultural distinction, and is harnessed for talent development.

Figure 7.2 shows how bio-ecological effectivity can be culturally selected or harnessed for specialization and domain-specific use. While the development of effectivity is relatively spontaneous, talent development is fundamentally a cultural phenomenon (Csikszentmihalyi & Robinson, 1986) and typically takes place in more formal (sometimes regimented) settings such as school or higher education institutions (see the branching out of personal effectivity to talent domains in Fig. 7.2). Hence,

Proposition 3 *Talent development follows the developmental process of increasing differentiation and integration, from developing bio-ecologically based*

effectivities to a wide range of talent in culturally created domains and institutionalized practices. The differential distribution of aptitudes and dispositions vis-à-vis environmental opportunities and challenges lead to different patterns of effectivity and a variety of talent developmental corridors and trajectories, and consequently a distinct social distribution of talent across a wide range of social-cultural activities.

Supporting evidence for increasingly differentiated talent trajectories is abundant (e.g., Csikszentmihalyi, Rathunde, & Whalen, 1993; Feist, 1998, 2006; Lubinski & Benbow, 2006). *Increasing differentiation* (Werner, 1967; Feldman, 1994) means that children in formative years should already manifest differential profiles of the five effectivities in an enriched modern social environment (usually the profile is "jagged" or uneven; Rose, 2016). The five broad domains of effectivity are meant to capture a person's strengths and readiness to take on challenges of systematically developing talent in hundreds and thousands of domains that are culturally valued or perceived as beneficial to achieving one's long-term goals. Figure 7.2 shows how different effectivities are further differentiated in the form of specialized talent or domain practice, be it music, mathematics, or engineering. However, as talent in a cultural domain involves more than one effectivity to develop (e.g., being expressive and technical at once in music, or being social, technical, intellectual, and expressive at the same time as a lawyer or political leader), one will witness *increasing integration* of effectivities through self-organization in talent development. An implication of this integration is that two musicians or two lawyers may have their own dominant effectivity in talent composition: A musician may have a strong expressive or technical inclination, and a lawyer may have a distinct intellectual or expressive style, so on and so forth.

The Growth of Individuality from Spontaneity to Purposive Acts

The picture of what effectivity or talent develops is incomplete without a provision of growing importance in self-direction. A skill-based account of effectivity, talent, and expert development is insufficient because talent development is always closely related to personal development, especially one's evolving individuality or selfhood (Edelman, 1995). If bio-ecological effectivities are extrinsically sensitive and adaptive, personal development is intrinsically robust (Lewis, 2000). Hence,

Proposition 4 *Talent development follows the tenet of evolving individuality or personhood as a result of maturation and developmental interaction with the environment, and consequently a changing pattern of forming spontaneous self-organized adaptive responses* (i.e., *characteristic adaptation), gradually shifting to increasingly purposive, future-oriented endeavor to perfect one's trade and make an impact* (i.e., *maximal adaptation).*

Self-directedness is a unique feature of human development. The person is not merely the product of natural development, but the producer of one's development in terms of *self-engendered* developmental interaction and experience (Dai & Renzulli, 2008; Feldman, 2003; Lerner, 2004). Thus, ECT postulates three critical developmental transitions from childhood to adolescence, (a) from other-direction to self-direction and self-regulation, (b) from playfulness to purposiveness (Csikszentmihalyi, 1996), and (c) from mastering foundational tools and instruments (effectivities) to making productive use of knowledge and skills (developing talents). These transitions significantly impact the sustainability of talent development.

The evolving individuality of a person has profound implications on how spontaneous self-organized responses (effectivities) lead to systematically developed competence (talents). In addition, talents are culturally created and valued (e.g., art and science), in that they carry a cultural function of enriching the meaningfulness of life, as well as making instrumental changes to improve human conditions. Thus, ECT postulates another bi-polar continuum in human functionality: instrumental (having practical impact) on the one hand and intrinsic (meaning-making) on the other hand (see Fig. 7.2). To be sure, it is conceivable that some talents are not socially condoned (e.g., burglary and computer hacking), but nevertheless systematically developed because they carry the "survive-and-thrive" value for the person involved. As Fig. 7.2 shows, increasing differentiation of competence (effectivities) further branches out talent domains to increase the person's sphere of a reaching power for making a difference (instrumental) or making the world (meaning-making). In other words, talent development becomes increasingly purposive for long-term gains and achievements.

Cognitive, Affective-Conative, and Social Processes Driving Talent Development

While the question of *what develops* (the diagonal axis in Fig. 7.1) helps reveal structural and functional changes over time, the delineation of *how it develops*

(the vertical axis) reveals the driving forces, endogenous and exogenous, behind the developmental changes. In the preceding section, I alluded to the self-directed nature of human development. ECT postulates two main self-regulated forces of adaptation as driving talent development: *characteristic* and *maximal* adaptation. Adaptation here is used in the general sense of behavioral and developmental function as achieving a better fit given the present opportunities, challenges, and resources (Fig. 7.3).

As shown in Fig. 7.3, sources of individual differences for the five forms of effectivity may come from biology in terms of aptitudes and dispositions vis-à-vis a respective stimulation or challenge (Lohman, 2005), as well as social-cultural variations in one's upbringings and exposure (Bronfenbrenner & Ceci, 1994). For conceptual clarity, *aptitude* is indicative of capacity or ability to deal with a particular challenge, and *disposition* is indicative of an affective-conative tendency to engage in a relevant task. In comparison, *characteristic adaptation* (CA), originally used in personality psychology (McAdams & Pals, 2006), here refers to characteristic ways in which a person seeks certain developmental opportunities to carve out a distinct niche via dynamical self-organization of effectivities into a talent trajectory. Simply put, CA reflects a niche-picking tendency of the developing person (see the arrow in Fig. 7.3). In contrast, *maximal adaptation* (MA[1]) refers to intensive efforts to perfect one's trade and surpass oneself when one becomes more purposeful and dedicated, which is typically mediated by social-cultural expectations and pedagogical and institutional support (Bereiter & Scardamalia, 1993; Ericsson, 2006; see the backward arrow). At a macro-level, Fig. 7.3 shows different levels of human agency at work in a relational developmental system, which is

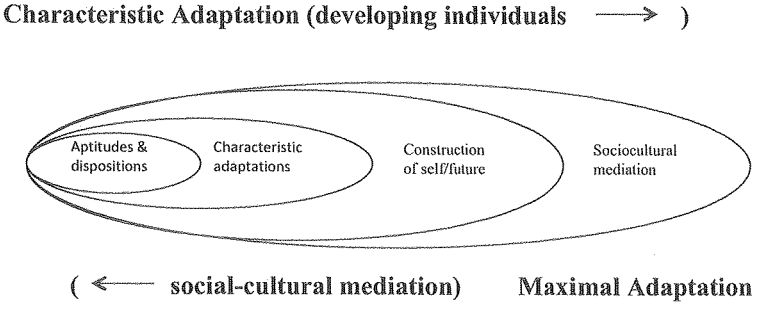

Fig. 7.3 A schematic representation of a nested multi-layered developmental system with two main regulatory forces

[1] Note that the acronyms CA and MA here should be distinguished from the same designations for chronological age (CA) and mental age (MA), as used in the psychometric intelligence literature.

nested, bidirectional, and reciprocating. However, a more micro-level process account is needed to explicate the psychosocial underpinnings of CA and MA. Hence,

Proposition 5 *There are interactive cognitive, affective-conative, and social processes underlying characteristic adaptation (CA) and maximal adaptation (MA), respectively, with CA and MA driving talent development from within (endogenously), and environmental forces that push and sustain talent development from without (exogenously), hence the push-sustain social mechanism.*

For CA, ECT postulates three interactive processes and conditions: (a) the ease of learning or differential learning curves given a task environment, (b) interest and selective affinity, and (c) favorable social conditions (including actual or perceived social comparative advantage, and available opportunities and resources). Although in some situations where children are too young to make a choice (e.g., training in violin or gymnastics at a very young age), CA still reveals itself in these three fit indexes. In comparison, psychosocial conditions that engender and sustain MA reflect a more challenging condition or environmental press (Murray, 1938); they include (a) increasingly challenging task demands (cognitive, sometimes social), (b) stress and affective costs, and (c) institutional expectations. Either way, each has its own push-sustain mechanism (Fig. 7.4).

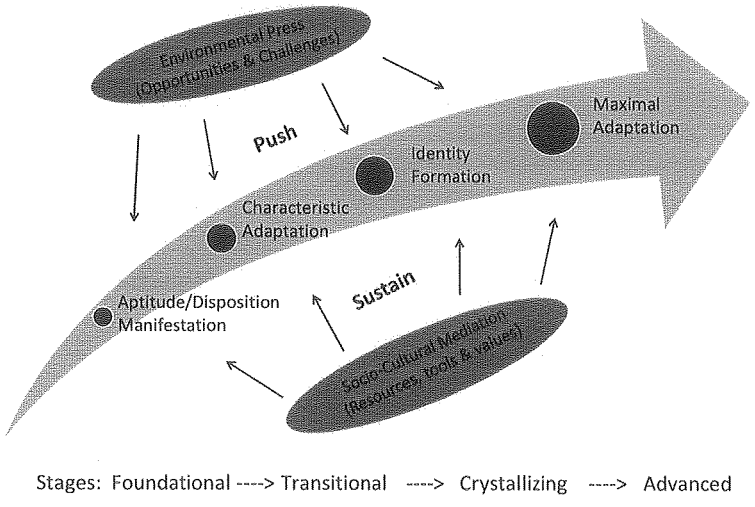

Fig. 7.4 An illustration of how endogenous momentum of talent development is "pushed" and "sustained" by exogenous forces

In terms of developmental consequences, what CA does is to enable the person to explore and expand a *personal action space* (PAS) and carve out a developmental niche, and what MA does is to enable the person to maximize one's contribution and impact.

Developmental Transition from Characteristic to Maximal Adaptation

As shown in Fig. 7.4, at the macro level (with a larger timescale) of individual development, ECT postulates four phases of talent development. To use music for illustration, demonstrating a music-related effectivity (Phase 1, Foundational) is one thing and pursuing a musical interest (Phase 2, Transitional) is another; becoming a musician (Phase 3, Crystallizing) or exploring a new form or personal style of musical expression (Phase 4, Advanced) even goes further beyond. These phases reflect the unfolding of different levels of developmental agency depicted in Fig. 7.3. The game changes, so to speak, as the person moves to later phases of talent development. What is noteworthy in Fig. 7.4 is how CA emerges and how developmental transition is made from CA and MA. The emergence of CA is indicated by a special patterning of strengths, interests, self-concepts, preferences, and actions (e.g., Ackerman, 2013; Lubinski & Benbow, 2006). The transition from CA to MA means not only that one is to become a more committed, self-directed, and serious learner, but also that one will be joining a community of professionals and thoroughly immersed in a domain of practice to fully explore one's individuality (Barron, 2006; Bloom, 1985). Hence,

Proposition 6 *An open, enriched environment conducive to CA and exploration and expansion of a personal action space will facilitate the transition from the Foundational to Transitional Phase, just as milestone events and crystallizing experiences* (Walters & Gardner, 1986) *will facilitate the transition from characteristic adaptation (CA) and maximal adaptation (MA) with purpose and commitment.*

Defined behaviorally, CA can include any niche-picking behaviors, such as taking certain electives, joining a math or history club, becoming a member of an *a cappella* group, or finding kindred spirits. It takes a relatively enriched, open environment (be it home, school, or community) for the child or adolescent to seek out certain experiences and explore a personal action space. In the same vein, without rich experiences of self-explorations and self-directed

Table 7.1 Four phases of talent development (TD) and the nature of tasks, affect-conative development, and social conditions and processes at each phase

Phases of TD	Developmental tasks that sustain TD	The nature of affective-conative development	Social conditions and processes
Advanced phase	Maximal adaptation (MA) Doing cutting-edge work Develop a personal niche	Vision/ perseverance	Institutionalized standards and norms; modus operandi
Crystallizing phase	Making commitment to a line of serious work	Identity/ commitment	Serious participation Mentorship
Transition phase	Characteristic adaptation (CA) Exploration/ expansion of a personal action space	Interest/ self-efficacy Selective affinity	Opportunity structure, Comparative advantage Autonomy support
Foundation phase	Manifestation of aptitudes and dispositions in foundational domains	Agency/will power	Typical/optimal condition Evocative interaction

activities (CA), it is difficult to develop a firm identity and deep commitment to a particular line of work, rendering unlikely the transition to MA (see Table 7.1 for task, affect, and social conditions that sustain talent development in each phase).

The Timing of the Onset and Duration of Talent Development Constrained by Domains and Life Cycle

The cultivation and fulfillment of human potential through talent development is fundamentally constrained by biology and life cycle; cognitive, emotional, and social maturity (or for that matter precocity) likely determines the proper timing of exposures and specific experiences and related payoff. However, based on bi-directional reciprocal interaction of biological maturity and environmental influences (Gottlieb, 1998), precocious development does not always mean rigidly following a biological clock, so to speak, but it can be culturally promoted so that certain aspects of human biology (at neural or genetic levels) are more cultivated than others based on cultural values and

priorities. Likewise, long-term development in some domains is more vulnerable to cognitive ageing effects or competition with new comers (often from younger generations). There are distinct domain differences in terms of the timing of peak performance or productivity. Hence,

***Proposition** 7 The typical timing of the onset and duration of talent development in cultural domains depend on the nature and complexity of a domain, especially with respect to the development and integration of the five foundational effectivities, which have their own developmental timetables.*

As revealed in Fig. 7.2, human functional complexity comes from two main sources. One source is the extent to which the realities are intuitively accessible through bodily experiences and direct observations; the other is the extent to which mastery entails complex symbolic maneuvering (i.e., *complexity of meaning-making* or understanding the world; Piaget, 1950), or the extent to which practical, instrumental changes one deems desirable involve high levels of technicality, broadly defined (i.e. *complexity of making instrumental changes*). On the embodied end, we should expect psychomotor and expressive effectivities to develop earlier, followed gradually by technical and intellectual effectivities on the symbolic end. However, all these aspects of individual development are mediated socially and, at least initially, for social purposes (Vygotsky, 1978). For example, a child might start to appreciate the rhythm and melody of music at the age of four (learning relying heavily on immediate bodily experiences, a biologically primary process), but sight reading may start at six (picking up symbolic skills, a biologically secondary process). These experiences are socially and culturally supported (i.e., the push-sustain social mechanism; Fig. 7.4). One important clue about the timing of development can be found in precocious talent development, especially the phenomenon of child prodigies (Feldman, 1986). The youngest talents tend to be in sport (psychomotor) and arts (expressive), and slightly older child prodigies also exist in mathematics and chess, suggesting that sheer intellectual power of reasoning and symbol manipulation (e.g., code cracking) can develop independent of social experiences and world knowledge.

It is instructive, therefore, to see many cultural domains in which talent does not emerge until much later. These domains may entail a prolonged accumulation of social experiences (social effectivity), insights, and deep knowledge to reach a high level of evolving complexity of meaning making (e.g., becoming a playwright or lawyer), just as prolonged specialized training and situated practice are essential to reach a high level of evolving complexity of making instrumental changes (e.g., becoming an engineer or master chef).

Complexity varies even within a domain. For instance, a poet only needs to master the expressiveness of language (e.g., various rhetoric devices), but a playwright must deal with characters, dramatic situations, and psychological subtleties way beyond language. This explains why young poets are more common and why playwrights usually take much longer to emerge (Lehman, 1953; see also Simonton, 2018). In the same vein, the spurt of creativity in a hypothetical-deductive manner seems more important in math and physics, wherein peak productivity tends to be achieved quite early, than in biology and sociology, wherein accumulation of facts and insights from bottom up (inductively) seems more important, and more seasoned scholars seem to have a distinct advantage. The complexity of meaning making also helps explain why natural scientists reach their peak creativity earlier than social scientists and scholars of humanities (Feist, 2006).

Timely Opportunities for Optimal Talent Development

While the typical timing and duration of talent development are domain specific, what is optimal for specific individuals may not be the same. What matters is timely *proximal processes* (Bronfenbrenner & Ceci, 1994) that are essential for initiating and sustaining a line of talent development. Hence,

Proposition 8 *The timely exposure to enriched environments that stimulate the development of the five foundational effectivities, the timely offer of deep experiences in talent domains, and the timely transition from CA and MA can escalate the pace of talent development and peak performance or productivity.*

Developmental timing of environmental experiences should follow the temporal order of foundational, transitional, crystallizing, and advanced phases, especially at two critical junctures: niche picking (CA) and exploration/expansion of a personal action space (PAS), and the transition from CA to MA. In this regard, ECT focuses on three time points: (a) timely exposure to enriched environments (Renzulli & Reis, 1997), typically in preschool and early school years for playful engagement of adult-structured activities; (b) timely offer of deep experience (Barron, 2006; Dai, Steenbergen-Hu, & Zhou, 2015), typically during adolescence; and (c) timely transition from CA and MA (Bloom, 1985), which can be accelerated for talented adolescents (Dai & Li, 2020; Dai et al., 2015).

What Distinguishes ECT from Other TD Theories and Models

In sum, ECT is predicated on the assumption of human evolving complexity as demonstrating personal agency at multiple levels, increasing differentiation and integration, and self-directedness and individuality through development (Dai, 2005, 2010, 2017, 2019; Dai & Renzulli, 2008). It postulates three essential features of talent development. First, with regard to what develops, it views human competencies (effectivity and talent) as emergent from person-environment transactional interaction; there is also increasing self-directedness in individual development. Second, in terms of how talent develops, ECT specifies individual niche-picking (characteristic adaptation) and a social-cultural force of stretching one's limits and surpassing oneself (maximal adaptation) as two main driving forces regulating talent development. Third, it stresses the developmental timing and duration as fundamentally constrained by life cycle and the nature of talent domains. The strengths of ECT can be seen when it is contrasted with other models of giftedness or talent development.

The Nature and Nurture of Giftedness and Talent

ECT does not hold a static capacity view of talent and giftedness (e.g., Galton, 1869) nor a purely environmentalist and experiential account of high human accomplishments (e.g., Ericsson et al., 1993, 2007). Rather, ECT views talent development as a process of successfully adapting to environmental opportunities and challenges and carving out a personal niche uniquely fit to realize one's potential to make contributions to certain aspects of human endeavor. This way, ECT transcends the dichotomous argument in favor of either nature or nurture, by specifying when *nature constrains nurture* (e.g., the role of aptitudes and dispositions and consequently characteristic adaptation; Ackerman, 2013), and when *nurture transcends or changes nature* (e.g., how maximal adaptation changes the neural, anatomical, physiological processes; Schlaug, 2001). Viewed dynamically, even the "gifted IQ" is an indicator of intellectual effectivity which, left unused, would decline (Ceci & Williams, 1997). Methodologically, the lifespan scope of ECT enables research to map out both distal factors emphasized by the nature camp (Gagné, 2009) and proximal factors emphasized by the nurture camp (Ericsson, 2006).

The Component Versus Systems Approach

Second, ECT is not a component model of talent in the sense of only identifying contributions of endogenous or exogenous factors without explicating how they work together to effect developmental processes and changes (e.g., Gagné, 2005; Lubinski & Benbow, 2006; Tannenbaum, 1983; see Ziegler & Phillipson, 2012 for a critique). Rather, ECT ascribes to a view of talent development as dynamic self-organization of the personhood at multiple levels (from neural to cognitive and behavioral; from basic approach-avoidance preferences to heightened intentions) through transactional interaction with a given task and social context. Such a view endorses relational causality or ontology (Plucker & Barab, 2005; Gottlieb, 2007; Overton, 2014), rather than isolating the role of many single components functioning independent of each other (see Hilpert & Marchand, 2018 on methodological ramifications).

ECT is not a merely process model of talent, either, if by "process" one refers to a step-by-step account of how a specific competence develops (e.g., Bloom, 1985; Ericsson & Williams, 2007). ECT attempts to map out how one's individuality evolves from early manifestation of effectivity vis-a-vis specific task and social environments all the way to highly developed individuality (a life purpose; Gruber, 1981), while interacting with developmental opportunities and challenges.

Domain-Centered Versus Person-Centered Approaches

Third, ECT was partly inspired by existing theories, such as Renzulli's (1986) three-ring theory, which is in effect a theory of *emergence* whereby task commitment and creative ideation are emergent properties of a person-environment functional relationship. It is also in keeping with Simonton's (1999) emergenic-epigenetic model in terms of stressing the contextual, dynamic, and emergent nature of talent. However, unlike Simonton's (1999) model, ECT provides a more elaborated time-sensitive and context-specific developmental account of talent, such as how a person's niche potential is cultivated by exploring and expanding one's personal action space (PAS), and what kind of push-sustain social mechanism is needed to support talent development. ECT also bears resemblance to Subotnik, Olszewski-Kubilius, and Worrell's (2011) mega-model of talent development, with a distinct focus on domain-specificity and

developmental processes, the centrality of psychosocial skills (in ECT, the emphasis on self-directedness and personal development), and an integration of both "being" and "doing" accounts of talent (see also Subotnik, Olszewski-Kubilius, & Worrell, 2019). However, ECT is a more person-centered rather than domain-centered theory in that it conceptualizes talent and talent development in a larger context of interaction of biological and cultural forces in shaping one's individuality. ECT does not treat "domain" as firmly setting the boundary for talent manifestation and development. Rather, what one developmentally constructs out of social-cultural encounters is what ultimately matters as to how one's talent is used, defined, combined, or expanded for productive or performing purposes. Thus, there are many pathways to talent accomplishment, some significantly constrained by cultural conventions and institutional norms, and others breaking the conventions and institutional norms by creating new niches and new forms and types of talent expression in the realm of instrumental changes or meaning-making (Fig. 7.2).

Implications of ECT for Gifted Education

A distinct advantage of ECT (particularly over component models) is its explication of what develops and how and when it develops. These specifications can directly inform policy matters, identification strategies, and interventions, making education practice more theory-driven and proactive.

Policy Implications of ECT

The non-reductionist, contextual, and dynamic view of giftedness and talent means that giftedness or talent is not a unitary entity (a capacity of some sort), sitting there to be discovered; rather, it is only revealed and evolved dynamically through developmental interaction with certain task and social environments (Propositions 1 and 2). This contextual-developmental view stands in sharp contrast to an essentialist view that treats giftedness and talent as a permanent quality that holds its identity, unity, and continuity over the course of life. The contextual-developmental view ECT represents also fully reckons with developmental diversity and emergent individual differences in talent in every step of human development, and thus is inclusive in its scope of service, while providing a broader psychosocial basis for practical purposes.

Identification as Developmental Prognosis, Not a Status Determination

ECT articulates human development as following the path of increasing differentiation and integration, not only in terms of bio-ecological effectivities and culturally defined talents (Proposition 3), but also in terms of self-directedness and increasingly crystallized self-direction and purpose (Proposition 4). Rather than setting a uniform operational definition of what giftedness or talent is and how it should be determined by a fixed set of criteria (i.e., a status definition), the principles of increasing differentiation and integration call for a practice of identification as providing developmental prognosis of what is likely to happen and what are some options given a particular diagnosis of the child's strengths and challenges. For Jen, this developmental prognosis not only generates a profile of effectivities, but also makes proactive recommendations as to, for example, where Jen may need to build strengths (e.g., overcoming shyness) or what talent domains she might explore as they involve pervasive use of the mathematical tool. For Joe, such developmental prognosis may involve a careful analysis of his personal action space (PAS), and how he might take advantage of his writing skills and couple it with a specific genre (e.g., children's literature). In addition, because we know the typical timing of the onset and important milestone events of talent development in specific domains (Proposition 7), purposefully creating opportunities for self-exploration is a way of identifying specific talent strengths. The role of teachers and school counselors (rather than contrived testing) for shepherding this process becomes crucial. For example, creating a talent profile management system in school will help teachers and counselors keep track of a student's progress along a particular talent trajectory or pathway, or weigh options for optimal academic and career development.

Aligning Education with Talent Trajectories and Developmental Changes

A main assumption of ECT is that individuals' characteristic adaptation (CA) can be harnessed to maximize their developmental outcomes. ECT explicitly articulates specific cognitive, affective-conative, and social conditions for the emergence of CA, and for the transition from CA and MA (Propositions 5 and 6). Characteristic adaptation (CA) in terms of patterns of emergent talent, interests, and preferences can be the basis for designing educational provisions (e.g., programs and courses) conducive to particular lines of talent

development. A distinct feature of ECT is its provision of education as integral part of human development (with its pedagogical tools and social-cultural support). In this regard, informal learning across home, community, and school can be highly valuable for the emergence of CA and self-sustained learning (Barron, 2006). Although it is difficult for educators to have 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 three timely educational experiences (Proposition 8): (a) timely exposure to enriched activities in which children's aptitudes and dispositions vis-à-vis five foundational domains will be manifested, (b) timely exposure to various cultural domains so that children/adolescents will demonstrate their CA, and (c) timely deep experiences in a domain to facilitate transition from CA to MA. For example, ECT postulates that self-engendered talent development (CA), when left to one's own devices, can hit its plateau or bottleneck, unless a more rigorous regiment of learning and training is put in place (MA). This issue is more likely to occur during adolescence and beyond. Conceptualized this way, the challenge of gifted and talented education (e.g., 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 urban planning). In this sense, ECT can be a guide for gifted programming every step of the way based on its four-phase framework.

Psychological Counseling and Guidance for Optimal Development

Gifted and talented children and adolescents may have special counseling needs because they arguably have more options, tougher challenges ahead, and more hurdles to overcome in individual development if they are to survive and thrive in their chosen lines of development. Evolving complexity for them implies that by living on the edge of competence (Bereiter & Scardamalia, 1993), developmental instability is more common for them (Dai & Renzulli, 2008). Throughout the four developmental phases, self-development is always crucial (even for young artists and athletes). Counseling can help talented teenagers to clarify their interests and aspirations, encourage them to explore talent domains that match their profiles. According to ECT, a main endogenous barrier for transition from CA to MA is affective in nature: how to find one's developmental niche is a life task that can be stressful. Counseling and guidance have a lot to offer in recognizing talented students' strengths and

accomplishments, while helping them cope with stress and envision their life possibilities (Dai et al., 2015). Taken together, ECT can be a highly useful tool of guidance.

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