De los genes al talento: la perspectiva DMGT/CMTD

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Abstract

This article offers an overview of the author's theory of talent development, called the *Comprehensive Model of Talent Development (CMTD)*. It brings into a unified whole two earlier models, the well-known *Differentiated Model of Giftedness and Talent (DMGT)*, and the more recently proposed *Developmental Model for Natural Abilities (DMNA)*. The DMGT defines talent development as the progressive transformation of outstanding natural abilities (called gifts) into outstanding knowledge and skills (called talents). Two types of catalysts, intrapersonal and environmental, actively moderate the talent development process. These four causal components dynamically interact to foster, or sometimes hinder, the emergence of talents. Research has shown that the four causal components, but especially the natural abilities and intrapersonal catalysts, have significant biological underpinnings. These biological roots first appeared in the form of 'basements' to the DMGT; they were eventually dynamically integrated into the *Developmental Model for Natural Abilities (DMNA)*, contributing to the growth of natural abilities through a developmental process based on maturation and informal learning, plus the necessary contribution of both sets of I and E catalysts. Their fusion into the CMTD creates a seamless developmental process that begins with the biological foundations and eventually culminates into high-level expertise.

Keywords: DMGT, DMNA, CMDT, giftedness, talent, talent development, catalysts, biological foundations, genetics, personality, environment.

Resumen

Este artículo ofrece una visión general de la teoría del autor sobre el desarrollo del talento, llamado el *Modelo Integral de Desarrollo del Talento* (*CMTD*). Se integran en un todo unificado dos modelos anteriores, el conocido como *Modelo Diferenciado de dotación y Talento* (*DMGT*), y el *Modelo de Desarrollo de Capacidades Naturales* (DMNA). El DMGT define el desarrollo de talento como la transformación progresiva de las capacidades naturales excepcionales (llamados dones) en conocimientos y capacidades (llamados talentos) excepcionales. Hay dos tipos de catalizadores, intrapersonales y ambientales, que activamente moderan el proceso de desarrollo del talento. Estos cuatro componentes causales interactúan dinámicamente para fomentar, o a veces dificultar, la aparición del talento. La investigación ha demostrado que los cuatro componentes causales, pero sobre todo las capacidades naturales y catalizadores intrapersonales, tienen bases biológicas significativas. Estas raíces biológicas aparecieron por primera vez en forma de "niveles" en el contexto del DMGT; fueron finalmente integrados dinámicamente en el *Modelo de Desarrollo de Capacidades Naturales* (*DMNA*), contribuyendo al crecimiento de las capacidades naturales a través de un proceso de desarrollo basado en la maduración y el aprendizaje informal, además de la necesaria contribución de ambos conjuntos de catalizadores intrapersonales y ambientales. Su fusión en el CMTD crea un proceso de desarrollo sin fisuras que se inicia con los fundamentos biológicos y finalmente culmina en competencias de alto nivel.

Palabras clave: Alta capacidad, talento, desarrollo del talento, catalizadores, fundamentos biológicos, personalidad, entorno.

From genes to talent: the DMGT/CMTD perspective

Why do some students excel in school while the majority of their peers obtain average or below average performances? What are the origins of excellence in school subjects, here labeled 'academic talent'? Just ask a dozen educators or scholars, and you will probably get a dozen somewhat distinct answers. And the same applies to parents, students, and the general public: most of us harbor our personal 'implicit theory' for the causal origins of academic talent. And one of the main characteristics of these personal or more scientific views is the tendency of each promoter to give preeminence to one source of influence over many others, to privilege one key 'ingredient' of success over the candidates defended by

other people. For some, the key resides in the quality of the family environment and support; for others, the main influence belongs to the school environment, and more specifically the classroom. Some specialists strongly defend time on task, these 10 000 hours of 'deliberate practice' (Ericsson, 2002; Gladwell, 2008) that are supposedly sufficient to create an expert out of almost every child. Some propose instead the importance of 'focus' (Goleman, 2013), or the significance of determination, perseverance, and grit (see Duckworth, Peterson, Matthews, & Kelly, 2007) as their key sources of success. Others will highlight the virtues of intrinsic motivation and intellectual curiosity (Von Stumm, Hell, & Chamorro-Premuzic, 2011), whereas some other group will propose the significance of a special 'mindset' (Dweck, 2006), where the plasticity of cognitive abilities predominates over more static and immutable potentialities. There are also those who defend the strength of individual differences in cognitive aptitudes. And these are only some of the more advertised key sources of academic excellence.

This article aims to relativize the alleged strengths of these 'causal spotlights' that various promoters defend as 'the key' to academic success and excellence. I intend instead to propose the complex interaction over time of a diversity of causal factors, including all of the above, whose strength of influence changes not only over the course of the basic educational trajectory, but also from individual to individual at any point in time. Taken individually, none of them has a crucial impact, except in very special circumstances, on the final educational outcome; but all play 'some' role on a daily basis in the complex choreography of talent emergence. I intend to demonstrate that cognitive aptitudes, anchored in the individual's biological and genetic foundations, act as building blocks of the numerous academic competencies acquired year after year through formal education, and that this process is continually modulated by two large ensembles of influences: intrapersonal catalysts that define an individual's temperament, personality, needs, and desires, as well as environmental catalysts present in each child's family, school, and social environment. This theory of talent development, born in the field of general education, but now applied to arts (McPherson & Williamon, 2006) and sports (Tranckle & Cushion, 2006), is called the *Comprehensive Model of Talent Development (CMTD)*. It recently evolved from the long-standing and well-known *Differentiating Model of Giftedness and Talent (DMGT)*, integrating in the process another recent addition, namely the

Developmental Model for Natural Abilities (DMNA). I will examine each of these models according to their chronological emergence.

Introducing the DMGT

1. Defining the key DMGT constructs

a. Giftedness and talent

Scholars and practitioners almost unanimous acknowledge that the concept of 'giftedness' represents two distinct realities: early emerging forms of giftedness with strong biological roots, as opposed to fully developed adult forms of 'giftedness'. Scholars express that distinction through pairs of terms such as potential/realization, aptitude/achievement, or promise/fulfillment. When I entered the field of gifted education in the late 1970s I immediately noticed that dichotomy, commonly expressed in expressions such as "Education's goal is to maximize each student's potential", or "Realizing one's potential is each person's lifelong challenge" (Gagné, 2009). Since two labels, giftedness and talent respectively, were available to describe outstanding abilities, it seemed logical to attach a distinct label to each of these two concepts. Thus were born the two basic definitions that constitute the core of the DMGT framework, presented below in their current form.

Giftedness designates the possession and use of untrained and spontaneously expressed outstanding natural abilities or aptitudes (called gifts), in at least one ability domain, to a degree that places an individual at least among the top 10% of age peers.

Talent designates the outstanding mastery of systematically developed competencies (knowledge and skills) in at least one field of human activity to a degree that places an individual at least among the top 10% of 'learning peers' (those having accumulated a similar amount of learning time from either current or past training).

Note how the DMGT clearly separates the concepts of giftedness, potential, aptitude, and natural abilities on the one hand, from those of talent, performance, achievement, systematically developed abilities, as well as expertise, eminence, and prodigiousness; it is one of the DMGT's unique qualities. The DMGT will stand—or fall—on the validity of that

basic distinction, especially on the acceptance of the giftedness part of this crucial duo of constructs. Note also that I use here the term 'ability' as an umbrella construct that covers both 'natural' abilities (aptitudes) and 'systematically developed' abilities (competencies).

b. Differential assessment of aptitudes and achievements

Even though we call aptitudes a 'potential', assessing their level involves measuring some form of performance. An example is the use of an IQ test to measure intellectual potential. So, as Gagné (2013) asked relevantly: "How can we hope to distinguish aptitude measures from achievement measures if both rely on some form of performance" (p. 201)? Indeed, the differences are not qualitative: there are no 'pure' measures of aptitude on one side and achievement on the other. Measures of natural abilities range over a continuum from indices much more typical of natural abilities to clearly accepted achievement measures. Angoff (1988) proposed ten differentiating characteristics between aptitude and achievement measures. These are summarized in Table 1. Angoff worded all the descriptions as *quantitative* differences between types of instruments; they simply lean in opposite directions with regard to each criterion. The disparities will appear strikingly if we compare well-known examples in each category, for instance the *Wechsler Intelligence Scale for Children (WISC-IV)* (Wechsler, 2003) as opposed to any semester exam in a school subject. The specificity (A) and recency (B) of contents differ markedly; the abilities assessed with the WISC will apply to the learning of any subject, whereas any school curriculum focuses on a particular subject (C). Similar clear differences will emerge as we continue down the list in Table 1.

Is there any hierarchy among these ten characteristics? The labels used in the DMGT ('natural' vs. 'systematically developed') point at Angoff's and Gagné's choice as the overarching differentiator, namely the strength of genetic input in the case of aptitudes as opposed to the capital role of practice in the case of competencies/talents (see Gagné, 2009, 2013, for a detailed discussion).

TABLE 1: Angoff's differentiating characteristics for aptitudes and competencies

	Aptitudes (natural abilities)	Competencies (systematically developed abilities)
	Content	
A	More *general* content	More *specific* content
B	'*Old formal*' learning	*Recent* acquisitions
C	More widely *generalizable*	*Narrower* transfer to other situations
	Processes	
D	Major *genetic* substratum	Major *practice* component
E	*Slow* growth	*Rapid* growth
F	*Resistance* to stimulation	*Susceptibility* to it
G	*Informal* learning	More *formal* learning
	Purpose	
H	*Prospective* use (predicting future learning)	*Retrospective* use (assessing amount learned)
I	Usable for *general population* evaluation	Limited to *systematically exposed individuals*
J	Usable before any formal learning	Assessment requires formal learning

c. The prevalence issue

How many people are gifted and/or talented? As shown in both definitions above, the DMGT proposes a clear answer: 'outstanding' means individuals who belong to the top 10% of the relevant reference group in terms of natural ability (for giftedness) or achievement (for talent). This generous choice for the initial threshold is counterbalanced by the recognition of levels or degrees of giftedness or talent. The DMGT's metric-based (MB) system of levels constitutes an intrinsic constituent of the DMGT. It has five hierarchically structured levels, with each successive level including the top 10% of the preceding one; they are labeled *mildly* (top 10%), *moderately* (top 1%), *highly* (top 1:1,000), *exceptionally* (top 1:10,000), and *extremely or profoundly* (top 1:100,000). These levels apply to every domain of giftedness and every field of talent (Gagné, 1998).

The prevalence question is crucial for both theoretical and practical reasons. From a theoretical standpoint, a prevalence estimate represents an important contribution toward a more precise definition of any normative construct (e.g., poverty, tallness, weight, most neurotic syndromes) that targets, as is the case with giftedness and talent, a

marginal subgroup within a population. Practically speaking, adopting for instance a threshold of 10% instead of 1%—a *tenfold* difference in estimated prevalence—has a huge impact on selection practices and talent-development services. These reasons no doubt explain why the 'how many' question is the second most common question—after "What do you mean by 'gifted (or talented)?"—that media people and the general public address to specialists in the field. The 'how many' question has no absolute answer; nowhere will we find a magical number that automatically separates those labeled gifted or talented from the rest of the population. The establishment of a proper threshold requires that professionals come to a consensus, just like nutritionists did when they established the various category thresholds for the body mass index (BMI). Unfortunately, no such consensus has yet been achieved in the various fields of talent development.

Keeping the above comments in mind, let us proceed with our overview of the DMGT. As shown in Figure 1, it brings together five components: gifts (*G*), talents (*T*), the talent development process (*D*), intrapersonal (*I*), and environmental catalysts (*E*). The first three constitute the core of the DMGT; their interaction summarizes the essence of the DMGT's conception of talent development, namely the progressive transformation of gifts into talents.

2. The talent development trio

a. Gifts (G)

The *DMGT* proposes six natural ability domains, four of them belonging to the mental realm (intellectual-*GI*, creative-*GC*, social-*GS*, perceptual-*GP*), and the other two to the physical realm (muscular-*GM,* motor control-*GR*). Natural abilities are not innate; they do develop, especially during childhood, through maturational processes and informal exercise (see section B-2). Yet, that development and level of expression are partially controlled by the individual's genetic endowment. We observe major individual differences in natural abilities in the daily lives of all children, both at home and at school. For instance, think of the intellectual abilities needed to learn to read, speak a foreign language, or understand new mathematical concepts; the creative abilities needed to

solve different kinds of problems and produce original work in the visual and performing arts, literature and science; the physical abilities involved in sports, music, and sculpture; the social abilities essential in interactions with classmates, teachers, and parents. Gifts can be observed more easily and directly in young children because environmental influences and systematic learning have not yet exerted their moderating influence in a significant way. However, they still show themselves in older children and even in adults through the facility and speed with which individuals acquire new competencies (knowledge and skills) in any field of human activity. Said differently, ease and speed in learning are the trademarks of giftedness: they contribute strongly to the learners' pace of progress, with an extremely rapid pace being the key characteristic of prodigies.

FIGURE 1. Gagné's *Differentiating Model of Giftedness and Talent* (DMGT)
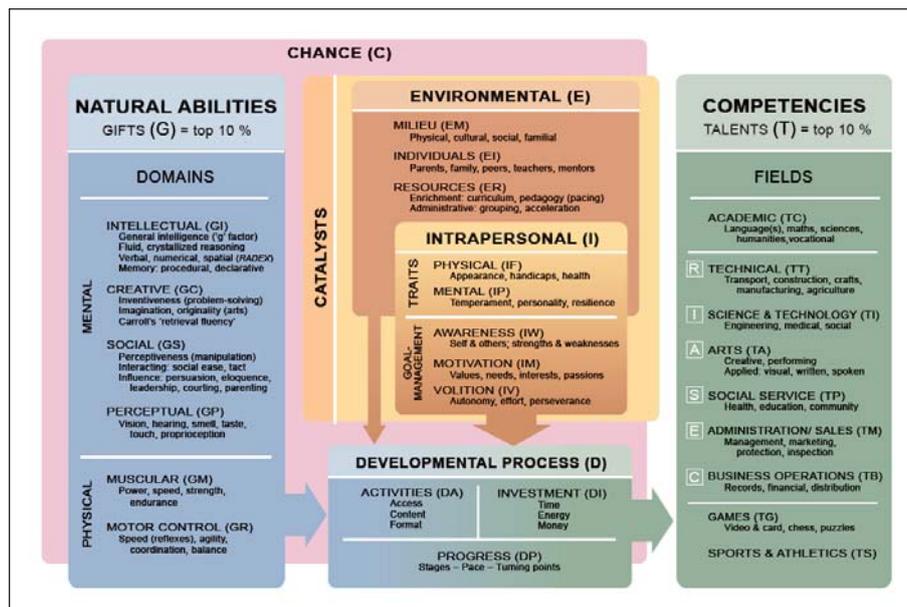
b. Talents (T)

As argued within the *DMGT* framework, talents progressively emerge from the transformation of these outstanding natural abilities or gifts into the well-trained and systematically developed competencies that define a particular field of human activity. On the potential-performance continuum, talents represent the performance pole, thus the outcome of the talent development process. Talent fields can be extremely diverse. Figure 1 shows nine talent subcomponents. Six of them correspond to the American College Testing's World-of-Work classification of occupations. It has its source in John Holland's (see Anastasi & Urbina, 1997) classification of work-related personality types: Realistic, Investigative, Artistic, Social, Enterprising, and Conventional (RIASEC). Three additional subcomponents complement the RIASEC taxonomy: pre-occupational academic (K-12) subjects, games, and sports. A particular natural ability can express itself in many different ways depending on the field(s) of activity adopted by an individual. For example, motor control (GR) can be modeled into the particular skills of a pianist, a painter, or a video game player. Similarly, cognitive processes can be modeled into the scientific reasoning of a chemist, the memorization and game analysis of a chess player, or the strategic planning of an athlete.

c. Developmental process (D)

Natural abilities or aptitudes serve as the "raw materials" or constituent elements of talents; they act through the talent development process. Talent development is formally defined as the systematic pursuit by *talentees*, over a significant period of time, of a structured program of activities leading to a specific excellence goal. The neologism *talentee* describes anyone actively involved in a systematic talent development program, whatever the field. The D component has three subcomponents (see Figure 1): activities (DA), investment (DI), and progress (DP), each of them subdivided again into multiple *facets*. Talent development begins when a child or adult gains access (DAA), through an identification or selection process, to a systematic program of activities. These activities include a specific content (DAC), the curriculum, offered within a specific learning environment (DAF or format). That learning environment may

be either unstructured (autodidactic learning) or structured (e.g., school, conservatory, sport organization). The investment (DI) subcomponent quantifies the intensity of the talent development process in terms of time (DIT), psychological energy (DIE), or money (DIM). Ericsson's (2002) concept of deliberate practice fits perfectly within the DIT and DIE facets. Finally, the progress (DP) of talentees from initial access to peak performance can be broken down into a series of stages (DPS; e.g., novice, advanced, proficient, expert). Its main quantitative representation is pace (DPP), or how fast—compared to learning peers—talentees are progressing toward their predefined excellence goal. The long-term developmental course of a talentee will be marked by a series of more or less crucial turning points (DPT) (e.g., being spotted by a teacher or coach, receiving an important scholarship, accidents, death of a family member or close friend).

3. The 'supporting cast'

Two large sets of catalysts, respectively labeled *intrapersonal* and *environmental* (see Figure 1) affect the talent development process, either positively or negatively.

a. Intrapersonal catalysts (I)

The I component has five subcomponents grouped into two main dimensions, namely stable traits (physical-IF, mental-IP), and goal management processes (self-awareness-IW, motivation-IM, and volition-IV). Within the mental or personality (IP) category, we find an extremely long list of descriptive qualities. The concept of temperament refers to behavioral predispositions with a strong hereditary component, whereas the term personality encompasses a large diversity of positive or negative acquired styles of behavior (Rothbart, 2012). The most widely accepted structure for personality attributes is called the Five-Factor Model (FFM). These factors are respectively labeled Extraversion (E), Neuroticism versus emotional stability (N), Agreeableness versus Antagonism (A), Conscientiousness (C), and Openness to experience (O). Think of OCEAN

as a mnemonic acronym! Research has shown that each factor has significant biological roots (McCrea, 2009).

The term 'motivation' usually brings to mind both the idea of what motivates us (IM) and how motivated (IV) we are, that is how much effort we are ready to invest in order to reach a particular goal. Within the framework of their *Action Control Theory*, two German scholars (see Corno, 1993: Kuhl & Beckman, 1985) proposed to differentiate the goal seeking process into distinct goal-setting activities, which would receive the motivation label (IM), from goal-attainment activities, which they labeled 'volition' or will power (IV). Talentees will first examine their values and their needs, as well as determine their interests or be swept by a sudden passion; these will serve to identify (IM) the specific talent goal they will be aiming for. The loftier that goal, the more efforts talentees will need to reach it (IV). Long-term goals placed at a vey high level require intense dedication, as well as daily acts of will power to maintain practice through obstacles, boredom, and occasional failure.

b. Environmental catalysts (E)

The E component is represented partially hidden behind the I component. This partial overlap signals the crucial filtering role that the I component plays with regard to environmental influences. The narrow downward arrow at the left indicates some limited direct E influences on the developmental process (e.g., social pressures, rules, or laws). But the bulk of environmental stimuli have to pass through the sieve of an individual's needs, interests, or personality traits. Talentees continually pick and choose which stimuli will receive their attention. The E component comprises three distinct subcomponents. The first one (EM) includes a diversity of environmental influences, from physical ones (e.g., climate, rural vs. urban living) to social, political, financial, or cultural ones. The second subcomponent (EI) focuses on the psychological influence of significant persons in the talentees' immediate environment. It includes of course parents and siblings, but also the larger family, teachers and trainers, peers, mentors, and even public figures adopted as role models by talentees. The third subcomponent (ER) covers all forms of talent development resources; the two traditional facets of curriculum enrichment and administrative practices directly parallel the 'content' and

'format' facets of the DA subcomponent earlier described. Here we adopt a broader perspective rather than examine resources from the subjective outlook of a given talentee's talent development course. Enrichment refers to specific talent development curricula or pedagogical strategies; its best-known example is called enrichment in density or curriculum compacting (Gagné, 2007; Reis, Burns, & Renzulli, 1992). Administrative decisions are traditionally subdivided into two main practices: (a) ability grouping (part-time or full-time), and (b) accelerative enrichment (e.g., early entrance to school, grade skipping). Gagné (2007) discusses in detail the virtues of these two enriching practices.

c. Note on the Chance factor (C)

Chance used to play the role of a fifth causal factor associated with the environment (e.g., the chance of being born in a particular family; the chance of the school in which the child is enrolled developing a program for talented students). But, strictly speaking it is *not* a causal factor. Just like the type of influence (positive *vs.* negative), chance characterizes the *predictability* (controllable *vs.* uncontrollable) of elements belonging to three other components (*G, I, or E*). Chance's crucial involvement is well summarized by Atkinson's (1978) belief that all human accomplishments can be ascribed to «two crucial rolls of the dice over which no individual exerts any personal control. These are the accidents of birth and background. One roll of the dice determines an individual's heredity; the other, his formative environment» (p. 221). These two impacts alone give a powerful role to chance in sowing the bases of a person's talent development possibilities.

4. Dynamic interactions

a. Complex patterns

The four groups of causal factors entertain a large diversity of complex dynamic interactions, between components as well as within them. Space does not allow a detailed survey, but consider for example that all efforts by teachers or parents to modify the characteristics of children and

students (e.g. interests, personality, beliefs, deviant behavior) illustrate E à I influences; of course, you can easily imagine influences in the opposite direction (e.g., students' passions influencing the behavior of parents or teachers). The most fundamental pattern of interactions involves of course the five components: as repeated again and again earlier, talent development involves all four causal components in a myriad of ways over long periods of time. Even talent, the outcome, can have a motivating impact on students: success breeds success! It can also influence environmental sources, parents as well as teachers. In summary, no causal component stands alone. They all interact with each other and with the learning process in very complex ways; and these interactions will differ very significantly from one person to the next. As I argued elsewhere after analyzing with the DMGT the life story of a young exceptionally talented Vietnamese guitarist (Gagné, 2000), individual talent emerges from complex and unique choreographies between the four groups of causal influences.

b. What makes the difference?

Even though all four causal components are active, it does not mean that they are equally powerful as agents of talent emergence. This is no doubt a truism at the individual level since each talented person follows a unique path toward excellence. But what can we say about averages? Are some factors generally recognized as more powerful predictors of outstanding performance? For all those involved in the talent development of gifted individuals, this is THE ultimate question. Of course, as I mentioned at the outset of this text, scholars and lay people entertain, more or less consciously, a personal set of beliefs—an implicit theory—about the hierarchy of these four groups of influences. With respect to the prediction of academic achievement, I proposed (see Gagné, 2004) the following decreasing order of influence: Gifts, Intrapersonal catalysts, Developmental activities, and Environmental influences (G, I, D, E).

In a nutshell, my choice of GI as topmost influence results from the thousand of studies having shown IQ measures to be the most powerful predictor of school achievement, at least during the K-12 years of schooling (Gottfredson, 1997; Macintosh, 2011). Intrapersonal catalysts appear in second place, mainly because of the powerful role of

motivational and volitional factors (e.g., conscientiousness, intrinsic & extrinsic motives, passion, grit). Time and effort involvement—Ericsson's concept of deliberate practice—have shown through dozens of studies completed over the past two decades their important role in differentiating levels of achievement. There is definite truth in the common saying: ¨Practice makes perfect". Yet, that component appears in third place mainly because IM and IV facets act constantly as the 'fuel' that will maintain the DI subcomponent in proper working effectiveness; Ericsson (2014) himself recognized that role. Attributing the bottom rank to environmental influences seems to contradict common wisdom, as well as the bulk of research on school achievement, especially on the role of family and classroom impacts. Yet, over the past two decades, many scholars have questioned the significance of 'nurture' (Harris, 1998; Pinker, 2002; Tooby & Cosmides, 1992); at the same time, a growing body of research from the field of behavioral genetics has shown that family influences have little permanent impact on siblings' personality similarities (Plomin & Price, 2003). In line with this revised view, the DMGT figure illustrates a major reason for the fourth rank attributed to environmental influences: we, as individuals, have definite power to select among the multiple environmental influences those that will receive our attention. As the saying goes: "We can bring a horse to the river, but we can't force it to drink".

B. Introducing the DMNA and CMTD

The DMGT constitutes a strictly behavioral representation of the numerous influences facilitating or blocking the growth of competencies in general, including their outstanding manifestations as talents. Among this large set of influences, natural abilities play, as we have seen above, a significant causal role. If we define these natural abilities as having significant biological roots, it becomes necessary to position these roots somewhere within the DMGT. These reflections led to four consecutive theoretical developments: (a) identifying the main categories and levels for the biological underpinnings of the main DMGT components; (b) integrating these biological basements within the existing DMGT framework; (c) determining the dynamic interaction between these biological bases and other influences responsible for the development of

natural abilities, thus creating the *Developmental Model for Natural Abilities* (DMNA); and (d) creating the *Comprehensive Model of Talent Development* (CMTD) as a natural extension of the two existing models. Let us look more closely at this evolution.

1. Biological underpinnings of talent development

Recurring questions from readers, coupled with personal observations, highlighted the absence in the DMGT of specific references to recognized non-behavioral influences on the growth of natural abilities (e.g., neurophysiological activity, type of muscle fibers) or the expression of intrapersonal catalysts (e.g., neurotransmitter action, genetic foundations of personality traits). The extraordinary growth of the neurosciences, thanks in large part to neuroimaging techniques, was also showing how brain structures and processes were directly correlated with individual differences in cognitive, social or physical abilities, interests, and other major behavioral functions. As described and illustrated (see Figure 1), the DMGT left no specific room for these distal sources of talent emergence.

Science has taken for granted for quite a long time some form of hierarchical organization of explanations, moving progressively from behavioral phenomena, down to physiology, microbiology, chemistry, then physics. For instance, Plomin, DeFries, Craig, and McGuffin (2003) describe functional genomics as "a bottom-up strategy in which the gene product is identified by its DNA sequence and the function of the gene product is traced through cells and then cell systems and eventually the brain" (p. 14). The expression 'bottom-up' made clear that such biological underpinnings would occupy a basement level under the strictly behavioral DMGT framework. The large number of levels of analysis suggested more than one basement. But how many should there be? Strictly speaking, identifying the proper number of levels was not crucial; it was also highly probable that experts in these fields would argue ad infinitum about the 'right' number of such explanatory levels. A brief examination of the literature suggested three underground levels.

Consequently, if we use a 'house' metaphor, we have the DMGT occupying the ground floor (see Figure 2), with three distinct basements underneath. The bottom basement (B-3) has been reserved for genotypic

foundations (e.g., gene identification, mutations, gene expression, epigenetic phenomena, protein production, and so forth). We could roughly label that third basement the *chemistry* level. The second basement, the *biology* level (B-2), is essentially devoted to microbiological and physiological processes; if one basement could be subdivided, it would probably be this one. This second basement moves us from genotypic to phenotypic phenomena; but their hidden nature, at least to the naked eye, justifies labeling them *endo*phenotypes; they correspond to "physical traits—phenotypes—that are not externally visible but are measurable. Endophenotypes can reveal the biological bases for a disorder better than behavioral symptoms because they represent a fundamental physical trait that is more closely tied to its source in a gene variant." (Nurnberger & Bierut, 2007, pp. 48-49). Similarly, Gottesman & Gould (2003) explain that in the case of phenomena having multi-gene origins endophenotypes provide "a means for identifying the 'downstream' traits or facets of clinical phenotypes, as well as the 'upstream' consequences of genes" (p. 637). Finally, the basement closest to ground level (B-1) includes anatomical or morphological characteristics that have been shown to impact abilities or intrapersonal catalysts. Most of these characteristics are observable *exophenotypes*, either directly (e.g., tallness in basketball, physical template in gymnastics) or indirectly (e.g., brain size through neuroimaging, muscle type through biopsy). Both endophenotypes and morphological traits are part of the complex hierarchical causal chain joining genes to physical abilities, and ultimately to systematically developed skills.

2. A developmental model for natural abilities (DMNA)

The creation of the DMNA had three aims: a) correct the wrong image of natural abilities given by common expressions such as 'innate talent' or 'God-given gifts', b) respond to scholars who question the relevance of the concept of giftedness, and c) correct the misunderstanding transmitted by well-meaning users of the DMGT who describe gifts as innate and talents as acquired. That simplistic bipolar view is wrong: gifts are not innate, they develop during the course of childhood, and sometimes continue to do so during adulthood. Of course, this developmental view of 'natural' abilities has to fight its way through a host of common

language expressions that maintain the ambiguity, like "she is a born musician,' or "it's God's gift," or "that's something you don't learn; either you have it or you don't!" So, if all these uses of the label 'innate' are incorrect, what does 'innateness' really mean?

FIGURE 2. The DMGT's biological underpinnings
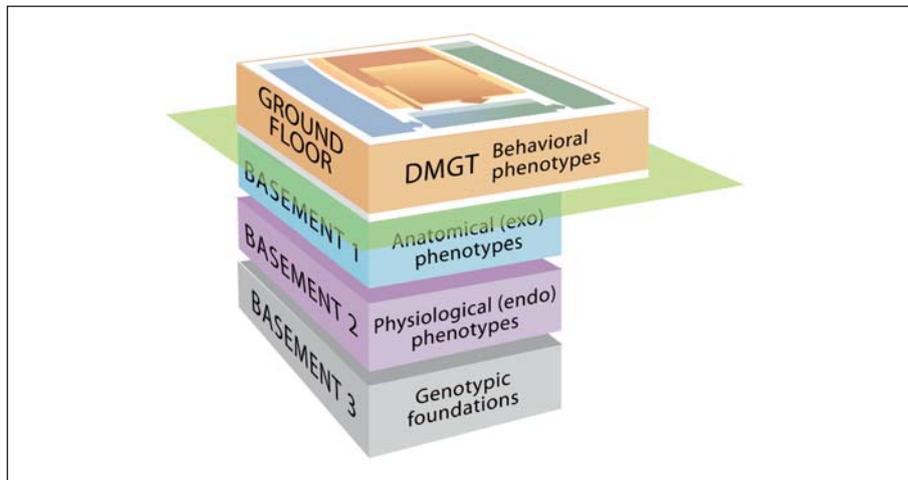
a. The proper meaning of 'innate'

When we say that little Mary is a 'born' pianist, we are certainly not implying that she began playing the piano in the nursery, nor that she was able to play a concerto within weeks of beginning her piano lessons. Describing her talent as innate only makes sense metaphorically. It will convey the idea that Mary progressed rapidly and seemingly effortlessly through her music curriculum, at a much more rapid pace than that of her learning peers. The same applies to any natural ability. Intellectually precocious children do not suddenly manifest an exceptional vocabulary or highly logical reasoning processes; they develop these cognitive abilities by going through the same developmental stages as any other child. The difference resides in the ease and speed with which they advance through these successive stages. The term 'precocious' says it all: they reach a given level of knowledge and reasoning *before* the vast

majority of learning peers. And the higher their intellectual giftedness, the more rapidly they will pass through these successive stages.

Researchers in behavioral genetics have given the term 'innate' a very specific definition. At the behavioral level, it implies "hard-wired, fixed action patterns of a species that are impervious to experience. Genetic influence on abilities and other complex traits does not denote the hard-wired deterministic effect of a single gene but rather probabilistic propensities of many genes in multiple-gene systems" (Plomin, 1998, p. 421). When we use that term to qualify the DMGT's natural abilities, we convey two false interpretations: (a) that the observed individual differences are immutable, and (b) that they are present at birth or, if not, appear suddenly with minimal training. Because of its restricted meaning, very few scientists use the term 'innate' to describe any type of natural ability or temperamental characteristic. Consequently, the term 'innate talent' should disappear from our technical vocabulary; more so, within the CMTD framework, it is a clear oxymoron, just as 'innately gifted' would be!

If natural abilities by themselves cannot be considered 'innate' as defined above, what exactly is innate? Where does the 'gift' in giftedness reside? Certainly not in the upper basement of Figure 2, since these anatomical structures require extensive development; most do not achieve their maturity until adolescence or adulthood. They are not innate in the way we defined that term. If we go one basement down to the level of biological or neurophysiological processes, we might be in a gray zone where it becomes difficult to separate innate processes from those that result from developmental activities. For example, most stages of embryogenesis are governed by genetic rules. If the development was strictly maturational, then we could probably speak of innateness. Most importantly, however, it is clear that the lowest basement, devoted to gene activity, is almost—but not totally, according to the new field of epigenetics— completely under inborn control.

In conclusion, except for still unexplained instances of seemingly sudden appearance (e.g., some 'savant' behavior; see Treffert, 2012), natural abilities are not innate, nor do they appear suddenly at some point during a person's early—or later—development. Just like any other type of ability, natural abilities need to develop progressively, in large part during a person's younger years; but they will do so spontaneously, without the structured learning and training activities typical of the talent development process.

b. Describing the DMNA

Now that we have argued that natural abilities do develop, how does their development proceed? Figure 3 shows that process through the *Developmental Model for Natural Abilities (DMNA)*. At first glance, it might look similar to the DMGT illustrated in Figure 1. But, a closer look shows major differences between the two, both at the component and the subcomponent levels. The main difference is of course a transfer of the G component from the left side to the right side; aptitudes—and their outstanding expression in gifts—are now the outcome of this particular developmental process. Here, the three levels of biological underpinnings, structural elements as well as processes, become the building blocks for the phenotypic behavioral abilities. Genotypic foundations (B-3) are isolated with an arrow showing their action on both endo- (B-2) and exo- (B-1) phenotypes. The two upper basements are linked because of their parallel influences on the growth and manifestation of outstanding aptitudes.

FIGURE 3. Gagné's *Developmental Model for Natural Abilities* (DMNA)
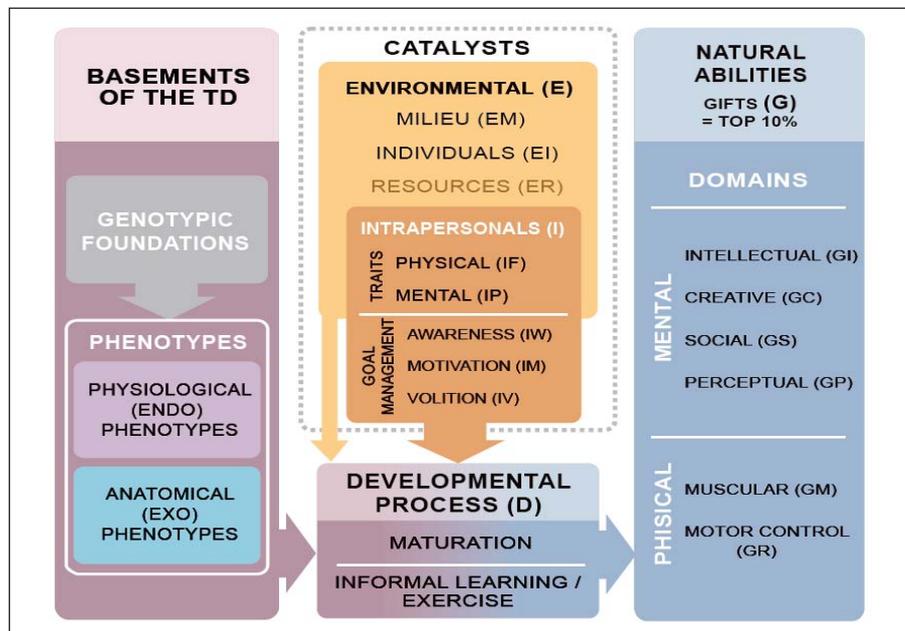
The developmental process specific to the DMNA appears here in summary form, with just two macro processes identified. Maturation of course covers a diversity of biological processes at each of the three basement levels, from embryogenesis upward, that govern the growth of mental and physical abilities. These maturational processes have no direct relationship with the talent development process itself; their role is to mold the natural abilities that will become, in turn, the building blocks of talents. As for the learning subcomponent, it is called 'informal' because it lacks the structured organization (e.g., curriculum, access rules, systematic schedule, formal assessment) typical of talent development activities. It takes the form of spontaneous learning acquired mostly subconsciously, with little daily or weekly attention to its growth. We could subdivide that informal process into the three subcomponents— activities, investment, progress—adopted in the case of talent development, but the lack of systematization would make these elements difficult to assess in any systematic way. Of course, parents will be able to identify their children's physical activities, the approximate amount of weekly investment, as well as their approximate standing among same sex age peers. Beyond that, we would be moving into talent development territory.

One cannot imagine a developmental process without catalytic influences, both intrapersonal and environmental. These two sets of catalysts appear here structurally unchanged, that is with the same subcomponents and facets. Of course, as we will see below, the exact contents within each element will differ, as well as their relative causal significance. For example, we cannot expect young children to show the same level of awareness (IW) toward their strengths and weaknesses as older individuals. But no doubt that intense interests and passions (IM) can manifest themselves very early. Similarly, within the realm of mental traits (IP), very large individual differences appear as soon as we start assessing any of them, either through self, parent, or teacher ratings. For example, in a famous research program, Jerome Kagan was able to distinguish inhibited toddlers from uninhibited ones (Kagan, 1989), and follow their development for a number of years. Children express very early their desire—or lack of it!—to engage in all kinds of daily activities: physical exercise, reading, playing a musical instrument, video games, playing with friends, and so forth. To some extent, their level of interest will influence the amount of their short-term or long-term investment, as

well as their decision to participate in a talent development program and to maintain their involvement in it.

Finally, environmental catalysts also play a significant role in fostering or hindering the development of human aptitudes; and all three subcomponents—Milieu, Individuals, and Resources—are involved. Here are just a few examples. With regard to the Milieu (EM), recent research has identified a hitherto unsuspected causal influence of individual differences in cognitive abilities: the burden imposed at a national level by parasitic and infectious diseases, called the DALY index. It explains to a significant degree cross-national differences in IQ (Hassall & Sherratt, 2011), as well as cross-state IQ differences in the USA (Eppig, Fincher, & Thornhill, 2011). It remains to be seen if a similar impact will appear at the level of individual differences. At this same EM level, recent studies have clearly shown that the degree of heritability of cognitive abilities varies with the socio-economic level of the families; the H component's importance decreases significantly in low-income families (Harden, Turkheimer, & Loehlin, 2007; Tucker-Drob & Harden, 2012). In fact, the whole area of gene by environment interactions belongs to the E component.

With regard to the Individuals (EI) subcomponent, any interventions by the parents to create a specific family environment, propitious either to general knowledge learning, to musical activities, or to athletic ones, could impact the development of related natural abilities. The same applies to their active efforts to involve their children in such activities, like visits to museums or concerts, winter or summer family sports activities, or any other activities that could foster a child's mental or physical natural gifts. In the case of the Resources (ER) subcomponent, government programs developed to improve the school preparedness (a.k.a. cognitive abilities) of at-risk children represent an interesting example of efforts to build up these natural abilities. But, since most of them target children with average or below average abilities, their relevance for the emergence of cognitive giftedness remains disputable.

In sum, natural abilities proceed through a developmental process somewhat similar to the talent development process. The same basic 'ingredients' are involved in fostering or hindering their growth. Of course, as Angoff (1988) perceptively highlighted, the most significant distinction between gifts and talents remains the amount of direct genetic contribution. The DMNA makes that point clear in its choice of building blocks.

. Merging the DMGT/DMNA into the CMTD

As soon as the DMNA was conceived, it became clear that joining the two developmental models into an *Comprehensive Model of Talent Development (CMDT)* would bring closure to my theoretical musings. Figure 4 illustrates the result, with the G component's central position ensuring the linkage between the buildup of outstanding natural abilities on the left side and the talent development process itself on the right side. The CMDT shows that talent development has its distal origins in the progressive buildup of natural abilities, as early as through the chance meeting of a sperm cell and an ovum. This produces a unique genotype in the fertilized egg. Through the complex process of embryogenesis, that single egg will multiply, its descendants will diversify into hundreds of different cell types, each with millions of exemplars, in a coordinated developmental process closely supervised by the genotype that will lead to the birth of a new baby. The maturation process will continue after birth as the various natural abilities, mental and physical, progressively take form at different levels from one individual to the next, thanks to the contribution of the two sets of catalysts, as well as innumerable daily occasions for informal learning. At some point, usually during childhood or early adolescence depending on the type of talent chosen, some gifted individuals, or those not too far from the DMGT's cutoff threshold of top 10 percent, will choose a talent field that fits their perceived profile of natural abilities and interests, and begin the long and complex journey leading to eventual top performance, as described through the DMGT framework. Some will go far beyond the basic 10% threshold of minimal talent, others will not, and the reasons behind the level of expertise achieved by these talentees will be as numerous as the facets that comprise the DMGT.

As a conclusion, it should be clear from this brief overview of the DMGT/CMTD that in his various publications the author has given much attention to terminological rigor. This extends well beyond the crucial differentiation between the concepts of giftedness and talent. For example, it specifies the general level of exceptionality (top 10%) and creates subcategories within the gifted and talented populations; it differentiates natural abilities (the G component) from personal dispositions (the I component); it subdivides precisely each of the five components of the DMGT into subcomponents (e.g., the six natural ability

domains, the nine groups of talent fields, the three groups of E influences), as well as facets (e.g., the various facets of intelligence or creativity, the three aspects of developmental involvement (DI) or progress (DP), and so forth; it situates clearly the position and role of biological underpinnings; and, finally, it combines all these 'ingredients' into a dynamically integrated developmental path.

FIGURE 4. Gagné's *Comprehensive Model of Talent Development* (CMTD)
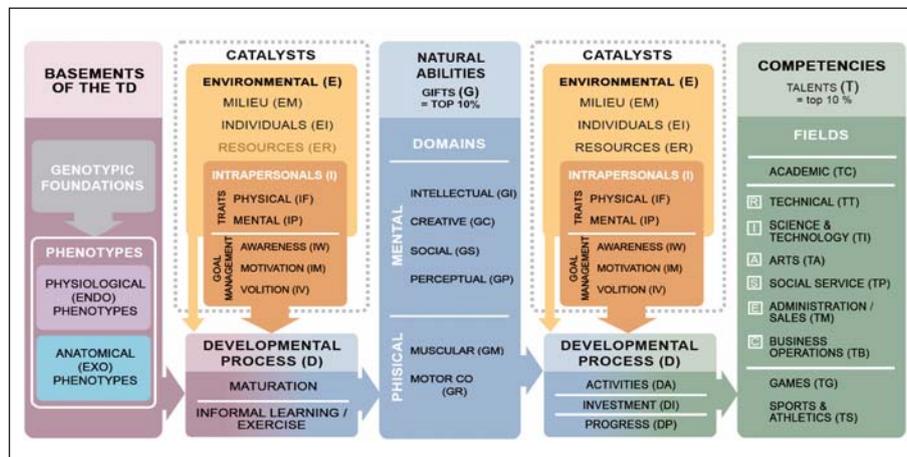
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[Interested readers will find on the author's website (gagne.francoys.wix.com/dmgt-mddt) a diversity of additional materials on the DMGT/CMTD and related subjects.]

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