Introduction to the Special Issue on Nature, Nurture, and the Development of Exceptional Competence

David Yun Dai & Laurence J. Coleman

The nature and nurture of exceptional competence is a key foundational issue for gifted education. This special issue is intended to present the most current thinking about the issue by a group of leading psychological researchers from diverse traditions. The introduction of the following 5 articles is organized around 3 themes: (a) nature versus nurture (additive influence of each), (b) nature and nurture (reciprocation and interaction of the 2), and (c) nature in nurture (nature mediated by, or revealed through, nurture). It is argued that the progression from the nature-nurture debate to interactionist perspectives, to a further consideration of nature and nurture as working as 1 system, represents a more refined and deeper understanding of the role of nature and nurture in the development of exceptional competence.

> All individual growth reflects constant and dynamic interaction between an organism, with its internal programs, and the environment, whose constituent properties are never wholly predictable....[T]hese dynamic interactions continue throughout active life, giving shape and meaning to an individual's existence and ultimate accomplishments.
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> —H. Gardner, 1997, p. 10

Introduction

The field of gifted education in the United States is witnessing a time of uncertainties: economic downturns and financial shortfalls, political expediencies, concerns over equity and social injustice, transitions to new systems of identification and programming, and so forth. Most of all, the very theoretical foundations of the field, the raison d'être of gifted education, are under scrutiny and heated debate (e.g., Borland, 2003; Coleman, 1996). It seems timely that we

David Yun Dai is Assistant Professor in the Department of Educational and Counseling Psychology at the State University of New York at Albany. Laurence J. Coleman is the Daso Herb Professor of Gifted Education at the University of Toledo, Toledo, OH.

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take a pause and reexamine our own assumptions in light of most current theoretical thinking and research evidence.

The conceptual roots of gifted education can be traced to Galton (1869/1978) and Terman (1925), both of whom posited two basic assumptions that are still deeply rooted in our thinking about the nature of giftedness: (a) Exceptional competence or performance has a strong genetic component; in other words, natural endowment plays a crucial role; and (b) the society at large ought to appreciate the gifted for the sake of its own welfare. In other words, the gifted is a natural resource that needs to be cultivated and protected. The first assumption is a knowledge claim, and the second is a value-laden argument of the pragmatic or political nature. This special issue focuses on the first assumption and provides current psychological theories and research on the issue by encompassing psychometric, behavioral genetics, developmental, and cognitive traditions. We first provide an overview of some key issues addressed by ensuing articles. At the end of this special issue we will discuss their implications for identification, programming, curriculum, teaching, and counseling.

Three Framing Issues and Their Historical and Theoretical Contexts

The notion of *giftedness* hinges on the issue of *human potential*: what people can accomplish given relevant experiences, resources, and support and how this potential develops. Giftedness is inherently a norm-referenced concept, implicating fundamental individual differences in human potential (Sternberg, 1993; Ziegler & Heller, 2000). Without a norm, we could not discuss giftedness. For example, the capacity to learn and speak a language would be an extraordinary gift or talent for a chimpanzee, but no one would label a person who can speak English or Japanese as gifted. However, a person who speaks 20 languages is likely to be labeled (linguistically) gifted because of its rarity (Sternberg, 1993). Giftedness as a description of excellence is also differentially defined for children and adults. A child only needs to demonstrate unique potential or promise to be seen as gifted or talented. Various ways of identifying that unique potential and verifying its predictive efficacy have been researched (e.g., Feldhusen & Jarwan, 2000; Lubinski & Benbow, 2000). In contrast, an adult is typically judged by his or her attainment, that is, the levels of excellence based on standards of a field. Recognition of this distinction is evident in definitions of giftedness (Coleman & Cross, 2005). In addition, there seems to be a consensus that the gifted potential has some degree of domain specificity (e.g., arts vs. academics), though scholars differ regarding the extent to which different domains have unique requirements or share a common set of attributes in learning, development, and performance. In terms of output or contributions, gifted accomplishments can also be of different kinds; some become master performers who execute highly challenging plans and actions with amazing facility, and others become creators who develop new lines of work, even new fields of human endeavor (Tannenbaum, 1997).

Galton (1869/1978) was probably the first person to turn speculation about some natural endowment into a scientific endeavor. He was not only convinced that genius is heritable, he also believed that a reliable measurement could be found to help identify it. Galton's inventiveness contributed to two major research traditions in the 20th century: psychometric measurement and quantitative design of behavioral genetics research. The former maps out lawfully distributed stable human traits (mainly in two broad categories: ability and personality), and the latter estimates the heritability (h^2) of these traits. The fundamental question in a Galtonian quest is to what extent are such specific human traits as intelligence or shyness inherited? Conversely, if genetic differences fail to account for the variation of a specific trait, then the sources of the variation must be related to environmental influences. Thus, as is the case on many developmental issues (e.g., language development; see Miller, 1993), debates on how to explain exceptional competence and performance recurrently take the form of the *nature versus nurture* argument (e.g., Howe, Davidson, & Sloboda, 1998).

The authors in this special issue restate and reinterpret the traditional debates around the theme of the nature-nurture issue. Taken together, three ways of framing the debate are evident: nature versus nurture, nature and nurture, and nature in nurture. Table 1 summarizes the contributions of the papers to the three issues. These three aspects of the nature-nurture issue can be easily mapped onto a scheme of three phases, which Dewey and Bentley (1949) argued underlie the progressive development of a theory. In the first phase of *self-action,* objects (nature or nurture) are considered as behaving under their own power. Thus, genetically based characteristics and environmental forces exert their agency and have their respective additive contributions. The issue becomes which one is more important. In the second phase of *interaction* (nature and nurture), objects are regarded as causally acting upon each other, leading to (a) *recip-*

Table 1
A Selective Overview of the Contents of the Five Articles

	Nature or nurture	Nature and nurture	Nature in nurture
Simonton	Emergenesis: Additive versus multiplicative Simple versus complex talents		Epigenetic development: Dynamic emergence
Ericsson, Nandagopal, and Roring	Distinction between everyday learning and deliberate practice Extended deliberated practice Individual diff. in motivation		"Nurture" changes "nature" The 10-year or 10,000-hour rule
Papierno, Ceci, Makel, and Williams	Absolute potential versus actualized potential: an empirical issue	Gene-environment interaction Multiplying effects (reciprocity) Equifinality	Proximal processes "Nurture" compensates "nature"
Lohman		Aptitude as context-specific Aptitude as readiness for specific educational treatments	"Nature" is always "nurtured" Stability and change at the upper end of achievement Requisite skills and dispositions for sustained development
Miller	Savants as unique cases of "natural talents"	Unique propensities and ecological niches	Circumvention and compensation as adaptation Missing components in savant talents

rocal effects, whereby they are mutually reinforcing, and (b) *interaction effects*, whereby unique endogenous and exogenous elements produce joint effects that neither one alone would produce. Finally, in the third phase of *transaction process* (nature in nurture), objects are seen as relating to each other in a union or within a system. In this sense, genetic effects depend on nurturing conditions and can manifest themselves only through nurture. In the following section, we provide an overview of the ensuing five articles according to the three-fold scheme.

Nature Versus Nurture: Respective Roles of Inherited Individual Characteristics and Environmental Experiences

It is not coincidental that the authors of the first and second articles both start with a discussion of Galton's legacy. While affirming Galton's nature assumption, Simonton (this issue, pp. 270–286; see also Simonton, 1999) presents a more complex, *emergenic-epigenetic* model of how giftedness unfolds. Simonton distinguishes between simple and complex forms of giftedness or natural talent. The *emergenic* principle states that the emergence of a *complex talent* requires multiple components (cognitive and affective) working in concert in a nonadditive, multiplicative fashion. A talent will not emerge unless all essential components are in place. The epigenetic theory postulates that all components for a talent are not in place at birth. Rather, these components may follow different maturation timetables in formative years, thus making the emergence of a talent difficult to predict.

In essence, Simonton asserts that giftedness or talent in complex domains never comes about as a unitary, well-packaged entity that unfolds in a deterministic manner. Rather, the emergence of a complex talent is a probabilistic process of being the right person (relative to one's age cohort), in the right place (goodness of fit vis-à-vis a domain), at the right time (good timing of developmental changes), among other factors (cf. Renzulli, 1990). As Simonton points out, the emergenesis-epigenesis of a talent is only half of the story. When one takes into account the role of nurturing conditions that likely instigate relevant talent components and provide opportunities for integrating these components, the emergence of a talent becomes even more precarious. Thus, while reaffirming a major role of natural endowment, Simonton also "unpackages" an emergent talent to reveal nature's intricacies. Given that what we witness as gifted or talented are always *phenotypes*, rather than genotypes (Coleman & Cross, 2000; Feldman, 2003), Simonton's theory provides a unique dynamic systems view of how giftedness emerges, and it provides rich heuristics for research on the diverse and complex origins of the variety and many manifestations of talents.

In contrast to Simonton, Ericsson, Nandagopal, and Roring (this issue, pp. 287–311) summon up a strong nurture argument against Galton's nature assumption. The sentiment expressed by Ericsson et al. is shared by other scholars who suspect that folk beliefs about giftedness or talent is likely a folk belief, rather than reality, and does not hold up well under rigorous scientific scrutiny (e.g., Howe et al., 1998). Research in social psychology found that human beings are biased to make *dispositional*, rather than *situational*, attributions when inferring the causes of other people's behavior or performance; that is, they tend to infer personal factors as being responsible for their behavior or performance, not situational ones, particularly if the behavior or performance deviates from the norm. This bias is called *fundamental attribution error* (Heider, 1958). Based on this research, some researchers argue that labeling someone gifted or talented reflects a misattribution (e.g., Tesch-Römer, 1998). In other words, giftedness or talent is not real, but part of people's naive psychology.

Instead of starting with the a priori assumption of fundamental individual differences in ability, which underlies most research on the gifted and talented, Ericsson et al. (this issue) examine adult expert behavior (gifted-like behavior) as a starting point. Using laboratory tasks to elicit reliably reproduced high-level, expert performance, he and his colleagues performed detailed task analysis of expert performance and examined cognitive and motivational factors that led to those high-level performances.

Based on their research, Ericsson et al. argue that *deliberate practice* (Ericsson, Krampe, & Tesch-Römer, 1993) is sufficient to explain high-level expertise, rendering the evocation of "innate talent" superfluous. Ericsson et al. provide evidence that extended deliberate practice, unlike daily practice, decreases dependence on general processing constraints, such as working memory (Ericsson & Lehmann, 1996), and that what is typically viewed as gifted performance (e.g., on memory tasks) has proved trainable (Ericsson et al., this issue). Although many researchers have criticized Ericsson for neglecting evidence of talent and confounding effects of self-selection in the acquisition of expertise (e.g., Sternberg, 1996), the main thrust of Ericsson's argument is to emphasize the lack of evidence indicating the constraints of genetically based individual differences on asymptotic (or peak) performance (barring such extreme cases as birth defects; Ericsson, 1998). Given his emphasis on the role of extended deliberate practice, Ericsson downplays the importance of ability differences and highlights the importance of another aspect of individual differences: motivational characteristics of a person (Ericsson et al., 1993)

The contrasting conclusions between Ericsson's environmentally-oriented expert performance approach and individual difference-oriented psychometric approach seems to be traceable to methodological differences. Differential psychology with its psychometric technique is concerned with trait-level description and inferring possible distal causes, such as general intelligence, which presumably facilitates the acquisition of high-level expertise. Research on expertise, on the other hand, attempts to elucidate component skills and knowledge as proximal causes (Schneider, 2000) and deliberate practice as a main proximal mechanism for their acquisition. Typically, distal causes are not within the radarscope of their research paradigm (see Dai, 2002, for a discussion of proximal vs. distal causes).

In a nutshell, the arguments from the nurture camp focused on the malleability of human abilities and the importance of environmental experiences and motivation. The nature camp emphasizes individual differences in learning curves (specifically, rates and asymptotes) and developmental potential. In principle, these two competing arguments are not contradictory. Genetic influences do not imply unmalleability (e.g., shyness may be genetically based, but can be modified as a result of environmental press and adaptive efforts). Conversely, something proved to be susceptible to environmental influences does not invalidate the role of potential genetic differences (e.g., turning an introvert into an extrovert does not negate the genetic basis of introversion). What is really unresolved is the issue of whether or not human malleability is an unconstrained one or whether or not biological constraints are trivial when compared to cultural tools, resources, and experiences. According to Schneider (2000), ability shortfalls might be partially compensated for by effort. This argument attempts to reconcile differences between those who stress ability differences and those who emphasize effort and motivation. However, some research has shown that individual differences increased as a result of training in a controlled setting (Baltes, 1998). Gagné (2005) recently showed that schooling has an individual difference augmenting, rather than equalizing, effect. However, there is also evidence that with more targeted training, effects of distal determinants, such as general intelligence, tend to diminish (Ackerman, 1988). Yet, empirically determining whether or not there are genetically based limits in developmental potential for a specific talent domain (i.e., niche potential) would entail maximizing related opportunities and experience for a group of people (Bronfenbrenner & Ceci, 1998) and holding their experience (and motivation) constant for months and years in order for individual variations in learning rates and performance limits to show through, which is an impossible proposition (Shiffrin, 1996). Ericsson et al. provide some examples of what aspects of biology are difficult to change and what are amenable to environmental interventions. Schlaug (2001) suggested structural and functional changes of the brain as developmental adaptations to music requirements in musicians' cognitive development. To resolve this nature-nurture controversy, we might need to invoke the concept of *thresholds*, that is, for different levels of attainment (world class achievement vs. local championship) in different domains (e.g., physics vs. biology), there might be different thresholds for both endogenous and exogenous requirements (Simonton, 1994).

Nature and Nurture: Reciprocal and Interaction Effects

A problem with the nature versus nurture debate is that, although one can estimate the hereditary and environmental influences of a trait, genetic and environmental forces in human development rarely work separately in an additive fashion (Moore, 2002). There seems to be a consensus in the research community that it is no longer plausible to consider genes as constant and immutable, operating in a manner independent of learning experiences. Therefore, many researchers have taken an alternative tack: considering where nature and nurture meet, how nature and nurture interact to produce developmental outcomes neither nature nor nurture alone can account for, which is the topic of the third article (Papierno, Ceci, Makel, & Williams, this issue, pp. 312–332).

The interactionist theory of development is partly inspired by behavioral genetic research. For example, the findings that identical twins' intelligence and personality look more similar in adolescence and adulthood than in childhood (Plomin, DeFries, Craig, & McGuffin, 2003) suggest the robustness of genetic influences in one's developmental trajectories. Behavioral genetics research also found that environments do have influences, but they influence individuals (e.g., siblings) in different ways, depending on individual characteristics (e.g., within-family, nongenetic variance; see Scarr, 1997).

Papierno et al. apply a bioecological theory of intellectual development (Ceci, 1996) to gifted and talented phenomena. They discuss two types of joint effects of nature and nurture. The first type is more quantitative: how an initial small input (of nature or nurture) can yield substantial outputs when the person and the environment *reciprocate*. This position is consistent with those mentioned earlier that environmental forces tend to augment, rather than reduce, individual differences. An important feature of the bioecological theory of talent development is its emphasis on *equifinality* (Wachs, 2000), meaning that different initial conditions may lead to similar outcomes, whether or not it is IQ performance or talent accomplishments. Thus, some may get an early start by virtue of their precocity (a genetic advantage), while others may get an early start by environmental stimulation and support. Yet their developmental outcomes may look similar.

The second type of interaction effects is qualitative: gene-environment interaction. Here, the role of genetics is understood as "active dispositions expressed in selective patterns of attention, action, and response" (Papierno et al., this issue), though whether specific manifested dispositions are genetic is an empirical question. These selective tendencies show the robustness of genetic influences on individual developmental trajectories. Besides the active self-selection effect, other researchers often point out evocative gene-environment correlations, that is, certain characteristics of the child (e.g., precocity in music or math) evoke specific reactions from the environment, triggering further responses and actions from the child, and the cycle of reciprocal interaction goes on (Scarr, 1992; Wachs, 1992). The challenge for researchers is to map out these active dispositions as *initial conditions* and how they interact with environmental circumstances to shape qualitatively different developmental pathways and trajectories; for example, some gear toward physical or inorganic sciences and others toward organic or life sciences (Lubinski & Benbow, 2000), and some become masters and others creators (Gardner, 1997; Tannenbaum, 1997).

A key concept in this bioecological model is *proximal* processes, an extended period of transactional experiences with specific objects or tasks and related social environments. In a sense, one can consider deliberate practice (Ericsson et al., this issue) and other learning activities as examples of proximal processes. However, as proximal processes are where nature and nurture meet, Papierno et al. ask two essential questions: How might these proximal processes vary among individuals of differing active or evocative dispositions, and how might these proximal processes differ from domain to domain? These questions force one to substantiate Simonton's hypothesized emergenic-epigenetic processes by providing domain-specific, rather than generic, models of talent development, to address the question of *how* nature and nurture interact. The last two articles address this how question involving academic domains and music and visual arts.

Nature in Nurture: How Nurture Mediates Nature, and How Nurture Reveals Nature

Although genes may set proximal processes into motion, as Papierno et al. (this issue) assert, once in motion, nature and nurture function as a union within the person, rather than two separate entities. The term nature in nurture has two meanings. First, with regard to most human traits, including human abilities and personality characteristics, *nature is always nurtured* to some extent, and, by being so, differs from its original being (e.g., genomes). There is a chain of physical, biological, and social events that mediate genetic effects and the development and expression of human traits. A *pure* natural talent in a culturally defined domain, distilled from its nurturing conditions, is an empty abstraction. Second, nature-in-nurture also means that personal characteristics always reveal themselves in a specific functional context, rather than outside of it. Thus, competence changes when functional context changes.

In the fourth article, Lohman (this issue, pp. 333–360) presents an aptitude perspective on talent development and its implications on identification. Although the term *aptitude* is often used to denote natural ability or potential (thus we typically consider IQ or SAT tests as aptitude tests), aptitude here refers to "the degree of readiness to learn and to perform well in a particular situation or fixed domain" (Lohman, p. 337). According to this perspective, determination of eligibility for gifted education should start with a detailed analysis of demands and affordances of learning tasks in which students are expected to engage. Based on this analysis, Lohman identifies four primary aptitudes for academic success: (a) prior achievement, (b) the ability to reason in the symbol systems used to communicate new knowledge in a domain, (c) interest, and (d) persistence.

Lohman presents a compelling argument for why more proximal, task-relevant aptitudes should be used as a basis for identification, rather than distal and generic ones, which have weaker psychological and statistical justification because of their low predictive efficacy. Lohman's justification for using more proximal aptitudes is also based on the following two assumptions: First, academic abilities are nurtured, rather than innate, and dynamic (developing), rather than static (see Sternberg, 2000, 2003, for a similar position); second, intellectual challenges vary at different stages of academic development, so aptitudes (and inaptitudes) change over time.

A distinct feature of Lohman's aptitude perspective is its emphasis on motivation (interest and persistence). He argues that sustained academic development (particularly at the advanced level) will not be possible without deep engagement and enduring effort, even for those highly able learners. This emphasis echoes Ericsson's argument for the role of extended deliberate practice or the 10-year rule.

While Lohman focuses on identification issues, Miller (this issue, pp. 361–373) uses savant cases to demonstrate two important points. First, Miller shows how *nature constrains nurture.* His detailed analysis of the workings of various "savant talents" reveals facility (aptitude), as well as hindrance (inaptitude). For example, savants' art works show a lack of central coherence typically present in normal artistic works. Miller conjectures that the inability to impose conceptual framework and exercise executive control may lead to this apparent deficit. This point seems to be associated with Simonton's theory of complex talents in which all essential components must be present in the person to ensure the emergence of such a talent. On the other hand, if savants manage to attain high-level competence despite the impediments, either the emergenic-epigenetic model needs modification (e.g., the compensatory role of environmental support and motivation) or the domains in which savants show talent simply do not require high degrees of intellectual skills.

Second, Miller shows *how nature shapes nurture.* With unique sensibilities (aptitudes) and intellectual impairments (inaptitudes), savants often manage to negotiate their developmental niches by circumventing and compensating. The process shows a fundamental biological tendency for self-organization: arranging its own way of optimal functioning given the resources available. Similar examples can be found in dyslexics who often show structural and functional differences from those who are not dyslexic in the way they process information; their reliance on visual spatial organization often leads to unusual creativity (West, 1991).

Taken together, Lohman and Miller provide examples of how nature and nurture are intimately connected. While Miller's analysis of savant talents provides a unique window through which we get a glimpse of how nature constrains and shapes nurture, Lohman presents a dynamic view of talent development in which aptitudes are never constant, but undergoing changes along the process. As one can see in Table 1, all five articles allude to the intricate relationships between nature and nurture, so much so that we cannot talk about one without the other. Furthermore, putting nature in nurturing contexts allows us to move beyond general questions about the role of nature and nurture that prove intractable or too broad to answer (Coleman & Cross, 2000). We need to get to specific individuals, specific domains, specific environmental conditions, and specific biological constraints, specific developmental pathways, specific types and levels of excellence; in short, we must provide a proper context for the question asked.

Summary

The five articles give us a synopsis of evolving issues in our understanding of how a talent is developed. We see a progression from the nature versus nurture debate, to an interactionist perspective that considers the interaction of the two, to a dynamic view of how nature (e.g., abilities) is always nurtured, and how nurture (e.g., learning) is constrained by nature. We also see a change from asking "what" (nature or nurture?) to asking "how" (how nature or nurture works, how nature constrains and shapes nurture, and how nurture organize and changes nature?). We suggest that only when we answer the question of how can we adequately answer the question of what.

Conclusion

The nature-nurture issue is destined to be a recurrent issue in our collective consciousness as we try to nurture our youths to the fullest of their potential. Our revisit to an old issue in the field may give some people a feeling of enough is enough (see Hunt, 1997). However, we believe that one often achieves new insights by revisiting an old issue (as a Chinese proverb goes), resulting in *progressive deepening* in our understanding of the issue (de Groot, 1978). Advances in understanding do not always take the form of definitive answers to some unsettled questions. Indeed, the authors of this special issue sometimes disagree on some key issues. However, scientific advances often depend on whether or not we cast old questions in a new light and whether or not we put them in proper contexts. We believe that the following articles will help us better frame and answer critical questions about the nature, the nurture, and the development of exceptional competence.

Admittedly, there are issues related to this topic that are not directly addressed by the authors, such as whether or not the onset of talent development in a domain influences ultimate accomplishments, whether or not there are critical or sensitive periods for a specific domain, or if the power law (the learning curve that peaks rapidly and then gradually declines) is the basis for the 10-year rule. It seems important that we ask in what way biology constrains human intelligence and creativity and in what way culture transcends those biological constraints (see Sternberg & Kaufman, 2002).

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