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A Unified Theory of Development: A Dialectic Integration of Nature and Nurture

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The understanding of nature and nurture within developmental science has evolved with alternating ascendance of one or the other as primary explanations for individual differences in life course trajectories of success or failure. A dialectical perspective emphasizing the interconnectedness of individual and context is suggested to interpret the evolution of developmental science in similar terms to those necessary to explain the development of individual children. A unified theory of development is proposed to integrate personal change, context, regulation, and representational models of development.

The attention of philosophers and then scientists to human development has always begun with a concern that children should grow up to be good citizens who would contribute to society through diligent labor, moral family life, civil obedience, and, more recently, to be happy while making these contributions. The motivation for these concerns was that there were many adults who were not. Although attention was paid to the socialization and education of children, it was ultimately in the service of improving adult performance. The societal concern has always had a life-span perspective. Without healthy, productive adults no culture could continue to be successful. This concern continues to be a major motivator for society to support child development research. Although the intellectual interests of contemporary developmental researchers range widely in cognitive and social–emotional domains, the political justification for supporting such studies is that they will lead to the understanding and ultimate prevention of behavioral problems that are costly to society.

With these motivations and supports there have been major advances in our understanding of the intellectual, emotional, and social behavior of children, adolescents, and adults. Moreover these understandings have increasingly involved multilevel processes cutting across disciplinary boundaries in the social and natural sciences. This progress has forced conceptual reorientations as earlier unidirectional views that biological or social circumstance controlled individual behavior are becoming multidirectional perspectives where individual behavior reciprocally changes both biological and social circumstance.

The models we use to understand how individuals change over time have increased in complexity from linear to interactive to transactive to multilevel dynamic systems. Was this progression in complexity an expression of empirical advances in our developmental research or is it related to more general progressions in the history of science as a whole? Several years ago during a discussion of a need for a critical social history of developmental psychology by a number of distinguished scientists (Bronfenbrenner, Kessel, Kessen, & White, 1986), Sheldon White argued that it is necessary to engage and deconstruct the history of the field in parallel with efforts to understand the child. He continued by pointing out that the study of development needs a self-concept, just as each child requires ''the building of some kind of self-referential, self-regulating, self-knowing set of structures.''

If there is a more sophisticated understanding of the development of humans, is there a more sophisticated understanding of the development of our science? The models we use to understand the history of our field from child psychology to developmental science should increase in complexity. Understanding developmental science requires developmental science. And as in the study of any

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historical process there should be hope that understanding the past will help us predict the future.

The premise of the general systems theories that arose in the 1930s was that there were general principles of organization in every scientific domain that were at a level of abstraction somewhere between mathematical formulations and the specific processes being studied (Boulding, 1956). This has become apparent in every discipline from physics to political science, as each has moved to models of dynamic regulation, where parts cannot be separated from wholes and useful predictions can only be made based on local interactions of multiple systems. The hope of the founders of general systems theory (cf. von Bertalanffy, 1968) was that scientists would use a top-down strategy to interpret empirical data from a complexity perspective (Sameroff, 1983). This aspiration was not realized because each science has tried to be as theoretically simplistic as possible, resisting the demise of deterministic models until overwhelmed by the complexity of empirical data. The science of psychology has been no exception.

Developmental research aspired to the dicta of Ockham's razor in the hope of finding simple basic elements and processes that would explain the emergence of life's complexity. Up through the 1960s and into the 1970s statistically significant *t* tests and analyses of variance gave an illusion that science was advancing, but when regression models became dominant and the metric changed to size of effects (Cohen, 1988), it became clear that the field was not doing well at explaining how children were growing up. Contemporary developmentalists are quite competent at short-term predictions of similar cognitive or emotional constructs but much worse at the prediction of long-term successful life adaptations starting from initial conditions. Increasingly, sophisticated statistical models have been sought to separate the behavioral signal of interest from the noise of real life. This effort has led to some frustration in the decreasing amounts of variance that can be attributed to any single factor when everything imaginable is controlled and obscured the possibility that the unexplained variance, the noise, might contain the signals of many other dimensions of the individual or context that are necessary for meaningful long-term predictive models.

Applicability may not be the most salient criteria for getting research accepted for publication, but it is highly salient for suggesting ways to change developmental outcomes. The science paid for by the public is increasingly being asked to meet a translational rather than a statistical criterion with the application of research to policy an important consideration (Huston, 2008). The primary question remains as to how we can improve the fate of individuals growing up in our society. To answer that question requires a continuing examination of the models we need both to study and to understand development. In what follows I will present a contemporary summary of what such models should contain and offer a suggestion for an integrated view of development that captures much of the variance that needs explaining. No part of what I propose has not been previously suggested by creative others. Combining these elements into a unified developmental theory acknowledges the contemporary zeitgeist moving toward more dynamic conceptualizations at every level of analysis that is taking place in every other scientific discipline.

A Rough History of the Nature Versus Nurture Question

Before complexity was simplicity. For developmental explanations, simplicity was expressed in appeals to aspects of an individual's nature or nurture. The history of developmental psychology has been characterized by swings between opinions that determinants of an individual's behavior could be found either in their irreducible fundamental units or in their irreducible fundamental experiences. The growth process between babyhood and adulthood could be explained either by appeals to *intrinsic* properties of the child or to *extrinsic* properties of experience. The nature–nurture question has been a central *content* of developmental research, but it can also be considered to be a major *context* for developmental research in its appeal to deterministic thinking. As a consequence the history of the nature–nurture question can be used as an organizing construct to understand the history of our field.

Practically, the nature–nurture question comes into play when a child has a problem and the question arises, ''Who is responsible?'' Most parents' first response is to blame the child and most professionals' first response is to blame the parents. However, most scientists know that it is both. It is both child and parent, but it is also neurons and neighborhoods, synapses and schools, proteins and peers, and genes and governments. But that conclusion does not explain how it is both. Do nature and nurture interact deterministically so that the proportions attributable to each can be decomposed or

do they transact probabilistically so that the contribution of each can only be an abstraction from the activity of dynamic systems? How this question has been answered in the course of recent history offers a window into how developmental science has evolved and a perspective on how the question will be answered in the future.

Since ancient times philosophers have weighed in with their perspectives on the relative influences of constitution and experience in determining the life course, but it is in the last few hundred years that these positions have been well articulated, most notably John Locke in the 17th century and Rousseau in the 18th. I will begin my rough historical account in the late 19th century with the beginnings of empirical psychological research in the work of Francis Galton (see Table 1). Francis Galton coined the ''nature versus nurture'' phrase and in his view inherited characteristics were the origins of human nature. The nurture counterpoint was most strongly stated in the work of John Watson in the 1920s who propounded a new approach he labeled *behaviorism*, extending Pavlov's conditioning processes to explain human individual differences. Learning theory came to dominate human developmental research for almost 50 years strengthened by the operant paradigms promoted in the work of the Skinnerians.

This tilt toward nurture began to shift in the 1960s under assault from three directions—ethology, behavioral genetics, and the cognitive revolution. Where S-R theorists had argued that the laws of learning were primary in explaining developmental change, ethologists were demonstrating that many complex behaviors did not seem to need any reinforcement (Lorenz, 1950) and that S-R contingencies that worked in one species did not work in another (Breland & Breland, 1961). For example, rats could learn to push a lever to avoid a shock but pigeons could not. Ethologists argued that the nature of the species put large restrictions on the effects of nurture such that certain prepared responses were impervious to experience (Seligman, 1970). Statistical advances and data from large samples of twins permitted behavioral geneticists to argue that the effects of genes and environments could be separated, and that very large proportions of behavioral differences could be explained by genetic differences (Defries & McLearn, 1973). The cognitive revolution characterized in the work of Jean Piaget placed the source of development in the mind of the child. Experience was necessary for the child to construct the world but it did not play a role in individual differences.

Table 1
Rough History of Nature–Nurture

Historical era	Empirical advance
1880–1940s—Nature	Inherited differences
	Instincts
1920–1950s—Nurture	Reinforcement theory
	Psychoanalytic theory
1960–1970s—Nature	Ethology—species differences
	Behavioral genetics
	Cognitive revolution
1980–1990s—Nurture	Poverty
	Social ecology
	Cultural deconstruction
2000–2010s—Nature	Molecular biology
	Neuroscience

Where the nativist shift in the 1960s was driven by advances in biological science, the nurturist shift in the 1980s was driven by three advances in the social science—the war on poverty, the concept of a social ecology, and cultural deconstruction. Where behaviorist research focused on proximal connections between reinforcements and performance, scientists in other social disciplines were arguing that economic circumstance was a major constraint on the availability of reinforcements, such that the developmental environments of the poor were deprived in contrast with those of the affluent. Similar individuals in different social classes would have quite different developmental outcomes. Bronfenbrenner (1977) in his vision of the social ecology offered a more differentiated model than provided by economics alone. He identified the distal influences of family, school, work, and culture on the availability of reinforcements to the child, providing a more comprehensive empirical model for predicting individual differences in development. The influence of postmodernist deconstruction was manifest in the emergence of a cultural psychology that went beyond cross-cultural descriptive studies. Meaning rather than behavior became dominant through demonstrations that the same child behaviors could be given different meanings in different societies leading to different developmental consequences, and conversely, different behaviors could be given the same meaning leading to the same consequences.

The new millennium coincided with another swing of the pendulum in the nativist direction, again tied to major advances in biological science. Neuroscience and molecular biology have been making major contributions to our understanding

of development with new technologies for imaging the brain and manipulating the genome. But, as will be discussed below, the more recent swings between nature and nurture have been getting shorter and their intermingling has been increasing.

An examination of Table 1 emphasizes the swings between the popularity of nature and nurture as developmental explanations. At each point in time there are strong adherents of both positions waiting for some new technological advance to reinforce their point of view. Although this polarity provides motivation for empirical innovation, it has the unfortunate side effect of inhibiting theoretical innovation. Despite the alternating claims that the argument is now closed by those on the frontier of new explorations of nature or nurture, the fact remains that after each advance most of the variance in long-term developmental outcomes is still unexplained. It is the pressure of unexplained variance that continually negates claims of ascendancy and dialectically motivates continuing exploration.

I have presented a descriptive case for the cycling of explanations between nature and nurture to raise the question if there is an explanation of the repetitive pattern. It could be interpreted as simply the result of technological or theoretical advances, but it also could be a phenomenon in itself. The development of the nature–nurture debate might follow developmental principles similar to those that regulate human development and the examination of the two in parallel might illuminate both.

Nonlinear Models of Development

An appreciation of cycling requires an appreciation of a number of nonlinear processes that I will discuss under the general rubric of dialectical theory with specific attention to a developmental helix and processes of differentiation and integration. Dialectics have been directly or indirectly emphasized for studying development and especially relationships (Hinde, 1997; Riegel, 1976). An initial approach to dialectics is best captured by consideration of the Taoist diagram of the dark yin and the light yang (see Figure 1) that emphasizes that opposites are in a mutually constituting relationship. They were created together and remain bound to each other. This philosophical statement is empirically validated at the most fundamental level of physics where quarks, the current basic entities, are always in a relationship with each other. At the most fundamental level of the universe there are no ultimate

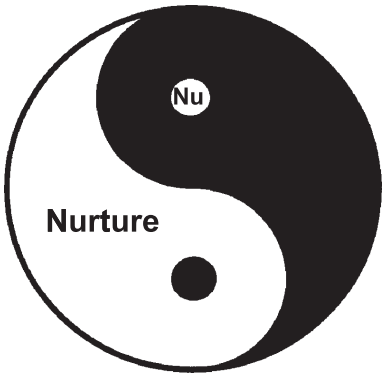

Figure 1. Unity of opposites and interpenetration of opposites in yin and yang diagram. Nu = nurture; Na = nature.

units, only ultimate relationships. In the dialectical yin–yang there is a *unity of opposites* and an *interpenetration of opposites*. The unity is indicated by the mutual embrace of the yin and the yang, as seen in the figure, but yin and yang also interpenetrate each other as depicted by the small black spot of yin within the yang and small white spot of yang within the yin.

In the psychological realm these ideas have been applied frequently, beginning with the philosophical writings of Hegel and most manifest in Piaget's theory of cognitive development. There is a unity of opposites between one's cognitions and the world that is being cognized. Without the world there would be nothing to cognize, and without the cognizer there would be no cognitions. But there is also an interpenetration of opposites. One's cognition leads to one's action which becomes part of the world (the small black dot in the white area), and then the changed world becomes a part of one's cognition (the small white dot in the black area) in a continuing dialectical progression.

The dialectical perspective on nature and nurture is that they mutually constitute each other. There is a *unity of opposites* in that development will not occur without both, and there is an *interpenetration of opposites* in that one's nature changes one's nurture and conversely one's nurture changes one's nature, as captured in current transactional models. Moreover, and most salient, without the one, the other would not exist. Species and their environments evolved together in a coactive and transactional relationship. Gottlieb's (1992) construct of probablistic epigenesis centered on the joint regulation by organismic and experiential factors that produced development with neither having priority over the other. The reciprocal bootstrapping between cultural change in groups and cognitive

change in individuals is well articulated by Cole (2006) in his description of human phylogeny.

Although Galton and Watson are the straw men that nurturists and nativists, respectively, rail against, both appreciated the unity of constitutions and environments. Galton (1876) recognized the influence of social class and wrote, ''Nature prevails enormously over nurture when the differences of nurture do not exceed what is commonly to be found among persons of the same rank in society and in the same country.'' Watson (1914), in turn, recognized that individual and species differences were important, ''effectiveness of habit training would be facilitated by knowledge of an animal's individual instinctive responses.'' The unity and interpenetration of nature and nurture will be more fully explored in the unified model of development to follow.

The Developmental Double Helix

The dynamic dialectical interplay between opposites can best be captured as an image of a helix that depicts the developmental aspects of changes over time as can be seen in Figure 2a. A simple example of a developmental progression is the daily cycle where spiraling to the right would be the movement toward day and spiraling left would be the movement toward night. Although this is a repetitive cycle, it becomes helical in that each day is different because of the experience of the previous night and each night is different because of the experience of the preceding day. A more complex example would be the development of representation in children (Werner, 1948). Initially, infants represent the world as images of here and now experiences. Preschoolers cycle over the same material but now have the capacity to depict images in drawings that may have a one-to-one correspondence to the images but are not the same as the images. In a few years they will recycle over the same contents but now with the ability to do abstract representations such as maps where the pictorial aspects may be completely eliminated in favor of words and symbols. Such developmental recycling also occurs in the social-emotional domain where relationship experiences and representations derived from early parent–child relationships are reworked as children enter into peer relationships and reworked again in the romantic relationships beginning in adolescence. Erikson (1959), although not known for his empiricism, was very articulate in describing the recycling of identity issues that are never resolved but through a balancing of opposites provide the impetus for each succeeding stage. The figure of the helix emphasizes that the same issues in a variety of domains are revisited again and again during development. The ubiquity of this helical concept is even found in Graduate Record Examination practice questions

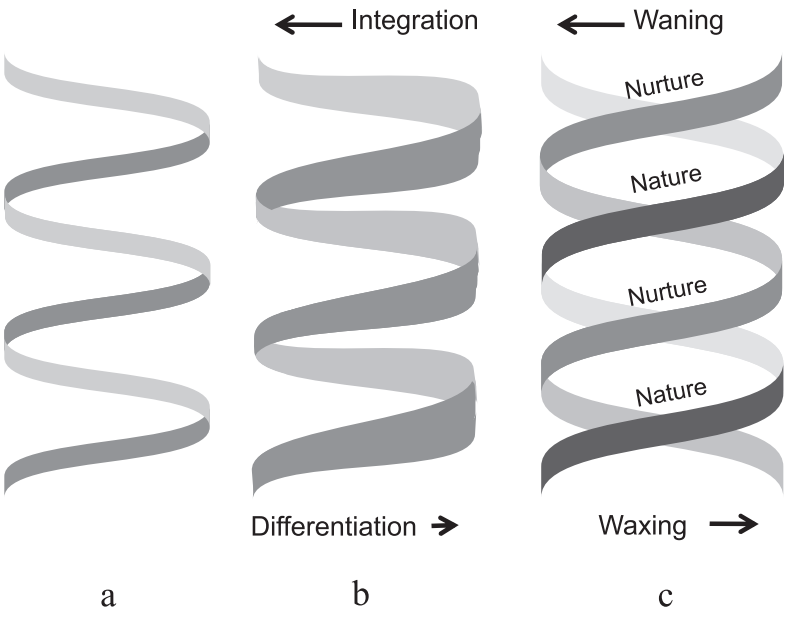

Figure 2. (a) Developmental helix. (b) Differentiation and integration of helix. (c) Developmental double helix of nature and nurture.

(Princeton Review, 2009) where a correct answer is ''Science advances in a *widening* spiral in that each new conceptual scheme *embraces* the phenomena explained by its predecessors and adds to those explanations.''

Differentiation and Hierarchic Integration

The developmental helix pushes us toward a more elaborate nonlinear process expressed as differentiation and hierarchic integration. As formulated in Werner's (1957) orthogenetic principle, ''Wherever development occurs it proceeds from a state of relative *globality and lack of differentiation* to a state of *increasing differentiation, articulation, and hierarchic integration*.'' If viewed within the helical metaphor in Figure 2b, we could consider the movement toward differentiation as going in one direction with a widening of the coil, as for example, the number of words in a child's vocabulary or the number of color concepts increases, and then the movement toward integration going in the other direction with a narrowing of the coil, as for example, the chunking of metacognition occurs, only once again to begin differentiating again as the number of metaconcepts increases.

If we consider the historical differentiation of nature, what began in Galton's laboratory as a catalogue of measurable differences in behavior was reconceptualized as really being differences in neurological electrical activity, and then as really being differences in neurotransmitter activity, and then as really being differences in genomic activity, and most recently as really being differences in epigenomic activity.

Analogously, there was also a historical differentiation of nurture where an early romantic conception of the power of mother love was reconceptualized as differences in the pattern of reinforcements provided by the parent, and then reconceptualized when it was discovered that differences in social circumstance constrained the patterns of reinforcement available to the child, and then reconceptualized when social circumstance was differentiated into the subsystems of the child's social ecology, and then reconceptualized when it was realized through social deconstruction that the effects of social ecology were constrained by the meanings that families and cultures imposed on behavior.

The progression of nature and nurture conceptions can be summarized by a double helix that captures their alternating differentiation and integration waxing and waning through time (see Figure 2c). Each new breakthrough initially goes through a stage of differentiation as a new methodology comes into play and then integration as it becomes connected to developmental phenomena. The developments in molecular biology would be a recent example on the nature side where the genome project produced the differentiated genes that now can be integrated into endophenotypes that have more proximal connections to behavior. On the nurture side, the differentiation of the social ecology into a set of subsystems of family, school, peer group, and neighborhood influences, for example, led to efforts at integrating its effect on development within comprehensive statistical models. Whether one gains ascendance over the other is a complex result of psychology (e.g., it is easier to conceptualize the parts we are made of than the wholes of which we are parts), anthropology (e.g., the preference in Western culture for individual-based rather than relationship-based explanations of behavior), sociology (e.g., whether there is a greater societal demand to mitigate the effects of biological disease or social disorder), and economics (e.g., whether investments in nature or nurture research offer the best opportunity to reduce the costs of developmental problems).

What is important in this discussion is to appreciate that there is a cycling between nature and nurture explanations of development that have a developmental course. The development of our science may be very similar to, and thus very useful for, understanding the development of human beings. The dialectics of differentiation and hierarchic integration may characterize all developmental processes.

We can come away from this discussion with one of two propositions. The first is that the cycling between nature and nurture will continue until either one or the other gets it right effectively ending the argument. Unfortunately, the problem of multifinality and equifinality undercuts this possibility (Cicchetti & Rogosch, 1996). On the nature side, whatever measure of individual differences has been discovered, two children with the same characteristics can have quite different outcomes and two children with different characteristics can have the same outcome. On the nurture side, whatever measure of the social environmental has been discovered, two children with the same experiences can have different outcomes and two children with quite different experiences can have the same outcome.

The second proposition is that nature and nurture represent a unity of opposites such that neither

can ever get it right on its own. Because of their interpenetration advances in our understanding of nature illuminate nurture and changes in our understanding of nature illuminate nature. Although the literature contains many references to the fact that one cannot separate nature from nurture, there are fewer references to how their unity operates. The rest of this article will be devoted to an effort to integrate contemporary advances in our understandings of both nature and nurture into a unified theory of development.

A Unified Theory of Development

Contemporary developmental science requires at least four models for understanding human growth: a *personal change* one, a *contextual* one, a *regulation* one, and a *representational* one. The *personal change model* is necessary for understanding the progression of competencies from infancy on. It requires unpacking the changing complexity of the individual as he or she moves from the sensorimotor functioning of infancy to increasingly intricate levels of cognition; from early attachments with a few caregivers to relationships with many peers, teachers, and others in the world beyond home and school; and from the early differentiation of self and other to the multifaceted personal and cultural identities of adolescence and adulthood. The *contextual model* is necessary to delineate the multiple sources of experience that augment or constrain individual development. The growing child is increasingly involved with a variety of social settings and institutions that have direct or indirect impact as exemplified in Bronfenbrenner's (1977) view of the social ecology. The *regulation model* adds a dynamic systems perspective to the relation between person and context. During early development, human regulation moves from the primarily biological to the psychological and social. What begins as the regulation of temperature, hunger, and arousal soon turns to regulation of attention, behavior, and social interactions. The last is the *representational model* where an individual's here and now experiences in the world is given a timeless existence in thought. These representations are the cognitive structures where experience is encoded at abstracted levels that provide an interpretive structure for new experiences, as well as a sense of self and other. Combining these four models offers a comprehensive view of the multiple parts, wholes, and their connecting processes that comprise human development.

Personal Change Model

Because psychology's central focus is on individuals, developmental psychology's main concerns have been on how children change over time. How one thinks about developmental change will have a clear influence on research objectives. Three ways of conceptualizing change can be seen in Figure 3—trait, growth, and developmental. If one believes that an individual consists of a set of unchanging traits then there is no need for developmental research. If development is considered a growth process then it can have classic epigenetic explanations in that all the parts are there to start with and it is their interactions that produce the changes in the phenotype, or it can be considered experience dependent but only as nutrition for the unfolding maturation process. Viewing personal change as a stage process can have a descriptive or theoretical meaning (Kessen, 1962). Descriptive stages are paraphrases for age and consist of lists of average achievements, for example, of 1-year-olds,

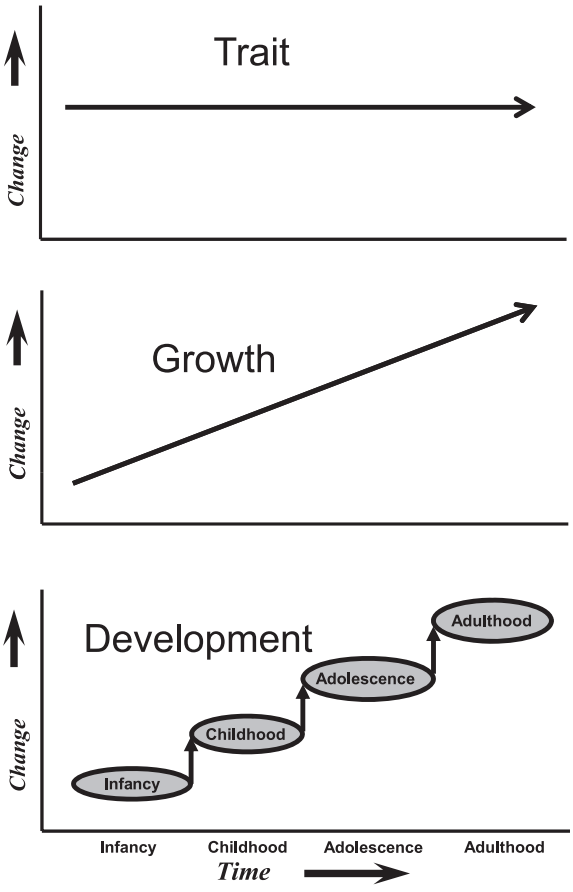

Figure 3. Personal change depicted as a trait, growth, or development.

2-year-olds, or 3-year-olds, similar to how intelligence quotient (IQ) tests are constructed. In contrast, the theoretical use of stage implies that there is a period of stability of functioning followed by a transition to a structurally different period of stability presumed to reflect more encompassing cognitive and social functioning. The classic examples of theoretical use of stages are in the writings of Freud and Piaget. Although there have been major revisions or rejections of these particular formulations, there are some generally accepted notions that within many domains individuals move from novices, to experts, to masters where they do not just do things better, they do things differently (Ericsson & Charness, 1994).

The general range of developmental changes has been extended well into adulthood and aging by the orientations of life span (Baltes, 1979) and life course theories (Elder, 1979) with their heavy emphasis on the importance of continuing alterations in the family, the workplace, and the historical epoch as individuals move into adulthood. The inability to separate individuals from context in the life-span models of adulthood provides a motivation to reconceptualize the importance of developmental context for younger individuals as well. The child or individual is not a unity and any model of the person also has to include the complex of psychological and underlying biological changes as well.

Contextual Model

Although developmental psychology is focused on individuals, it has become clear that understanding change requires an analysis of an individual's experience. Behavior, in general, and development, in particular, cannot be separated from the social context. Our understanding of experience has moved from a focus on primary caregivers to multiple other sources of socialization. There were many predecessors who felt that families, schools, neighborhoods, and culture had influences on development, but Bronfenbrenner turned these ideas into a comprehensive framework with predictions of how these settings affect the child but also how they affect each other. Although his terminology of microsystems, mesosystems, macrosystems, exosystems, and chronosystems may not be universally accepted, his principles that the family, school, and community are all intertwined in explaining any particular child's progress is now universally acknowledged (see Figure 4).

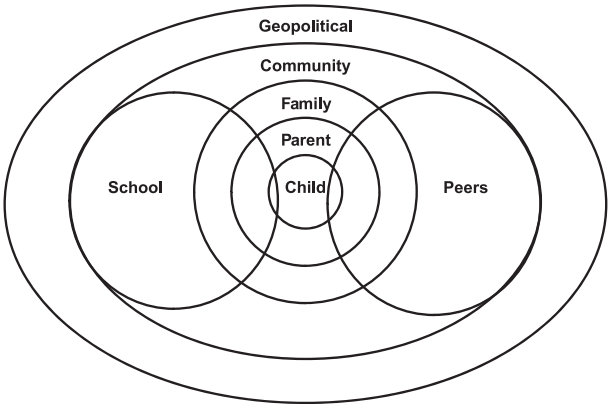

Figure 4. Social-ecological model of context.

Traditionally, social contacts were considered to expand from participation wholly in the family microsystem into later contact with the peer group and school system. Today, however, many infants are placed in out-of-home group child care in the first months of life. Each of these settings has its own system properties such that their contributions to the development of the child are only one of many institutional functions. For example, the administration of a school setting needs attention to financing, hiring, training of staff, and building maintenance before it can perform its putative function of caring for or educating children (Maxwell, 2009). Thus, a sociological analysis of such settings provides information about its ability to impact children.

Attention to the effects on children of changing settings over time must be augmented by attention to changing characteristics of individuals within a setting. Contemporary social models take a life course perspective that includes the interlinked life trajectories of not only the child but other family members (Elder, Johnson, & Crosnoe, 2003). For example, experience for the child may be quite different if the mother is in her teens with limited education, or in her 30s after completing professional training and entry into the job force.

Capturing the complex effects of multiple environmental situations has been a daunting enterprise requiring vast sample sizes to capture the unique contributions of each setting. An alternative methodology to dimensionalize the negative or positive quality of a child's experience has been the use of multiple or cumulative risk or promotive factor scores. For example, a set of data on the effects of a number of environmental variables on adolescent development was provided by a study of a large group of Philadelphia families (Furstenberg, Cook, Eccles, Elder, & Sameroff, 1999).

In the Philadelphia project 20 environmental factors were assessed and combined to approximate an ecological model containing six contextual subsystems. These were *Family Processes* that included support for autonomy, behavior control, parental involvement, and family climate; *Parent Characteristics* that included mental health, sense of efficacy, resourcefulness, and level of education; *Family Structure* that included the parents' marital status and socioeconomic indicators of household crowding and welfare status; *Family Management* composed of variables of institutional involvement, informal networks, social resources, and adjustments to economic pressure; *Peers* that included indicators of association with prosocial and antisocial peers; and *Community* that included census tract information on average income and educational level of the neighborhood, a parent report of neighborhood problems, and measures of the adolescent's school climate. In addition to the large number of ecological variables, we used a wide array of youth developmental outcomes in five domains: *Psychological Adjustment*, *Self-Competence*, *Conduct Problems*, *Extracurricular Involvement*, and *Academic Performance*.

For the environmental risk effects analyses each of the 20 variables was dichotomized with approximately one fourth of the families in the high-risk group and then the number of high risk conditions summed. When we examined the relation between the multiple risk factor score and the five adolescent outcomes, there were large declines in outcome with increasing risk and a substantial overlap in slope for each (Sameroff, 2006). Although this kind of epidemiological research does not unpack the processes by which each individual is impacted by contextual experience, it does document the multiple factors in the environment that are candidates for more specific analyses.

We also examined the effects of promotive influences in the Philadelphia study. Sameroff (1999) proposed that a better term for the positive end of the risk dimension would be *promotive* rather than protective factors. A promotive factor would have a positive effect in both high- and low-risk populations, which is far more common than a protective factor that only facilitates the development of high-risk children. We created a set of promotive factors by cutting each of our environmental variables at the top quartile, rather than the bottom, and summing them. The effects of the multiple promotive factor score mirrored the effects of the multiple risk score. Children from families with many promotive factors did substantially better than children from families with few promotive factors on each of our array of adolescent outcomes. For the youth in the Philadelphia sample, the more risk factors, the worse the outcomes, and the more promotive factors, the better the outcomes. In sum, context includes a constellation of environmental influences that have general effects on child development, fostering child development at one end and inhibiting it at the other.

Of great significance for the life course, these effects play out over time as a manifestation of the Matthew effect, ''To the man who has, more will be given until he grows rich; the man who has not will lose what little he has'' (Matthew 13:12). In a study of high- and low-IQ 4-year-olds we tracked their academic achievement through high school (Gutman, Sameroff, & Cole, 2003). The low-IQ group living in low contextual risk conditions consistently did better than the high-IQ group living in high risk conditions. Over time promotive or risky contextual effects either fostered or wiped out prior individual competence.

Regulation Model

The third component of the unified theory is the *regulation model* reflecting the systems orientation of modern science (Sameroff, 1983). The idea that that the child is in a dynamic rather than passive relationship with experience has become a basic tenet of contemporary developmental psychology. However, most of the rhetoric is about ''self''-regulation. Whether it is Piaget's assimilation-accommodation model in cognition or Rothbart's (1981) reactivity and self-regulatory view of temperament, equilibration is primarily a characteristic native to the child. The context is necessary as a source of passive experiences that stimulate individual adaptation, but has no active role in shaping that adaptation. These views promote a belief that regulation is a property of the person. However, self-regulation mainly occurs in a social surround that is actively engaged in ''other''-regulation. At the biological level the self-regulatory activity of genes is intimately connected to the other-regulatory activity of the surrounding cell cytoplasm. In Thelen's (1989) view of dynamic systems other-regulation is provided by the strange attractors of chaos theory. The self-regulation leading to an infant's neurologically based coordination of walking is constrained by the other-regulation of the child's muscle development, the strange attractor.

This issue of the developmental expansion of self-regulation to include other-regulation is

captured by the *ice-cream-cone-in-a-can* model of development (Sameroff & Fiese, 2000) depicted in Figure 5. The developmental changes in the relation between individual and context are represented as an expanding cone within a cylinder. The balance between other-regulation and self-regulation shifts as the child is able to take on more and more responsibility for his or her own well-being. The infant, who at birth could not survive without the caregiving environment, eventually reaches adulthood and can become part of the other-regulation of a new infant, beginning the next generation.

It is parents who keep children warm, feed them, and cuddle them when they cry; peers who provide children with knowledge about the range and limits of their social behavior; and teachers who socialize children into group behavior as well as regulate cognition into socially constructed domains of knowledge. Although these other-regulators can be considered background to the emergence of inherent individual differences in regulatory capacities, there has been much evidence from longitudinal research among humans and cross-fostering studies in other animals that ''self''-regulatory capacities are heavily influenced by the experience of regulation provided by caregivers. The capacity for self-regulation arises through the actions of others. This regulation by others provides the increasingly complex social, emotional, and cognitive experiences to which the child must self-regulate and the safety net when self-regulation fails. Children's cognition to a large extent is not derived from direct experiences with the environment but based on interpretations provided by others (Gelman, 2009). Moreover, these regulations are embedded not only in the relation between child and context but also in the additional relations between family and their cultural and economic situations (Raver, 2004). These regulatory systems range from the here-and-now experiences of parent–child interactions to governmental concern with the burden of national debt that will be passed on the next generation and to conservationists' concerns with the fate of the planet as a viable environment for future generations of humans.

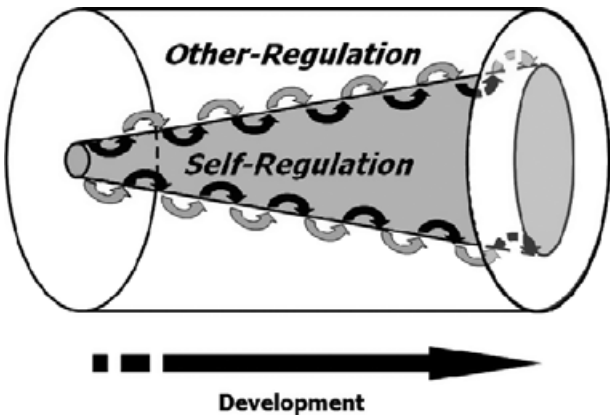

Figure 5. Transactional relations between self-regulation and other-regulation.

Early functional physiological self-regulation of sleep, crying, and attention are augmented by caregiving that provides children with regulatory experiences to help them quiet down on the one hand and become more attentive on the other. Sleep is an interesting example where biological regulation becomes psychological regulation through social regulation. As wakefulness begins to emerge as a distinct state it is expanded and contracted by interactions with caregivers who stimulate alertness and facilitate sleepiness. Although it remains an essential biological process, eventually it takes on a large degree of self-regulation as the child and then adult make active decisions about waking time and sleeping time. But this agentic decision making remains intimately connected with other-regulation in terms of the demands of school and work for specific periods of wakefulness.

Robert Emde and I with a group of colleagues (Sameroff & Emde, 1989) in an attempt to describe mental health diagnoses for infants argued for a position that infant diagnoses could not be separated from relationship diagnoses. Our point was that in early development life is a ''we-ness'' rather than an ''I-ness.'' The developmental and clinical question in this case is when does diagnosis become individualized, at what stage does a child have a self-regulation problem instead of an other-regulation problem? One answer is to identify the point in development when areas of self-regulation become independent of initial regulatory contexts and are carried into new relationships. Children who have imaginary playmates provide an interesting perspective on the relation between self- and other-regulation. The more preschoolers engaged in fantasy and pretense, the more sophisticated their theory of mind (Taylor & Carlson, 2009).

Generally, research into self-regulation has focused on part processes, such as emotion or attention. Such empirical isolation obscures the larger picture in which many interacting systems are playing significant roles. Without regulation provided by the social context, for example, nutrition and temperature, the young child would not survive to engage in emotional or attentional processes.

Transactional Regulation

The previous discussion of the need for a construct of other-regulation to complete an understanding of self-regulation leads now to how the relation between self and other operates developmentally and for this we turn to the transactional model (Sameroff & Chandler, 1975). Transactions are omnipresent. Everything in the universe is affecting something else or is being affected by something else. In the transactional model the development of the child is a product of the continuous dynamic interactions of the child and the experience provided by his or her social settings. What is core to the transactional model is the analytic emphasis placed on the interdependent effects of the child and environment and is depicted in the bidirectional arrows between self and other in Figure 5.

In a recent book on the topic (Sameroff, 2009), a number of researchers documented transactional processes in cognitive and social-emotional domains where agents in the family, school, and cultural contexts altered the course of children's development in both positive and negative directions. Transactional examples have been typically in the behavioral domain with an emphasis on parent–child mutual exacerbations producing problem behavior in both partners (Patterson, 1986). More recently, transactions have been recognized in teacher–student relationships where the effects of the teacher on the child in one grade will change the reaction of the teacher in the next moving the student to higher or lower levels of competence (Morrison & Connor, 2009). Multilevel transactions have also been documented where not only the parent and child are transacting with each other but both are also transacting with cultural practices (Bornstein, 2009).

Vygotsky's (1978) zone of proximal development is analogous to transactional other-regulation in cognitive development. Successful socialization and particularly good education is based on fitting experience to the developmental status of the child. As children create their understanding of the world, the world is made more complex through steps in a curriculum to move them along toward some societal goal of mature thought. Arithmetic is an excellent example where as soon as children learn to add, they are required to learn to subtract, following which they are taught to multiply and divide. Each step is a transactional regulation of the environment by the teacher to keep one step ahead of the child's mathematical regulation. Similarly, in the social realm increases in social responsibility are paced to the success of the adjustment to previous levels of responsibility (Rogoff, 2003).

In a more popular vein Gladwell (2008) describes the life course of a number of eminent individuals in sports, commerce, and technology, where equally competent children did not achieve similar greatness because of the lack of social, educational, or technological possibilities. In each case initial advantage scaffolded the child to be able to elicit and make use of a series of opportunities documenting the transactional progression that eventually led to eminence.

Representational Model

Representations are encodings of experience. They are a more or less elaborated internal summary of the external world. They include the cognitive representations where the external world is internalized, the social representations where relationships become working models, the cultural representations of different ethnicities or social classes, and the developmental theories discussed here. Representations are obviously not the same as what they represent. They have an adaptive function of bringing order to a variable world, producing a set of expectations of how things should fit together.

We have long been familiar with such representations as perceptual constancy in which objects are perceived as being a certain size even when the sensory size is manipulated. In such a summation certain aspects are selected and others ignored. In the representation of a square for example, the size, color, and texture of the square object may be ignored. Analogously, when representations are made of a social object such as a parent, certain features are included in the representation and others are ignored. Research using the adult attachment interview (Main & Goldwyn, 1984) has found that representations of parents are often idealized, where only positive aspects are included in the mental model. Although the links between the quality of representations of child–parent relationships during infancy and those during adulthood are far from direct, early working models of attachment do seem to have long-term consequences for adult development (Sroufe, Egeland, Carlson, & Collins, 2005).

Similarly, parents create representations of their children that emphasize certain aspects, deemphasize others, and have stability over time independent of the child's actual characteristics. We had parents rate their infants' temperament

during the 1st year of life following a structured interaction sequence (Seifer, Sameroff, Barrett, & Krafchuk, 1994). We also had them rate the temperament of six unfamiliar infants engaged in the same interaction sequence. The average correlation in temperament ratings of the unfamiliar infants between mothers and trained observers was .84 with none below .60. The average correlation in temperament ratings between mothers and trained observers for their own children was .35 with a range down to −.40. Mothers were very good raters of other people's children but very poor raters of their own due to the personal representations that they imposed on their observations. Documenting such differences in parent representations would be of no more than intellectual interest, if there were not consequences for the later development of the child. For example, infants whose mothers perceived them as problematic criers during infancy increased their crying during toddlerhood and had higher problem behavior scores when they were preschoolers (McKenzie & McDonough, 2009).

Individual well-being is also a result of meaningful cultural engagement with desirable everyday routines that have a script, goals, and values (Weisner, 2002). Meaningfulness, a key component of cultural analyses, is primarily found in coherent representations. Evidence of a positive effect of meaning systems can be found in Fiese and Winter's (2009) descriptions of how family routines provide a narrative representation for the rest of the family members that allows the whole to continue adaptive functioning despite the variability in the behavior of the parts. Evidence of a negative effect of lack of meaningfulness is in a study of native Canadian youth who showed much higher levels of suicide and other problem behavior when there were large inconsistencies in cultural continuity from one generation to another (Chandler, Lalonde, Sokol, & Hallett, 2003). The order or disorder in a family or society's representation of itself affects the adaptive functioning of its members.

Unifying the Theory of Development

Now that the four models necessary for a theory of development have been described, I can proceed to integrate them into a comprehensive view that contains most known influences on life trajectories. I will begin with a structural depiction of the components of the personal and contextual models containing all the pieces relevant to development. I will then add the regulation and change component of the personal model to capture the processes that produce the life course and then finish the unified theory with an overlay of the representational model.

Structural Formulation

The self is composed of a set of interacting psychological and biological processes. The psychological domains overlap in cognitive and emotional realms of intelligence, mental health, social competence, and identity, among others. These are depicted as the set of grey, overlapping circles comprising the psychological part of the self in Figure 6. Each of these psychological domains is subserved by and interacts with a set of interacting biological processes, including neurophysiology, neuroendocrinology, proteomics, epigenomics, and genomics that are depicted as a set of black, overlapping circles. Together the gray and black circles comprise the *biopsychological* self system. This self-regulation system interacts with the other-regulation system, depicted by the surrounding white circles, representing the many interacting settings of the social ecology, including family, school, neighborhood, community, and overarching geopolitical influences. Taken together the three sets of overlapping circles comprise the *biopsychosocial* aspects of the individual in context.

Process Formulation

The process formulation adds the personal change time dimension to the biopsychosocial model, which can be viewed as either a *growth model,* where the biopsychological aspects increase quantitatively over time but there is no change in their interrelationships as in the cone image (see Figure 5) or a *developmental model,* where the aspects have qualitative shifts in organization in which there are changing relations among the biopsychosocial aspects (see Figure 7).

Evolutionary theory has provided a fruitful analog for understanding the transitions that lead from one developmental stage to another. As opposed to the gradualist understanding of evolutionary changes originally proposed by Darwin that would look like the growth model, Eldredge and Gould (1972) argued that evolution was characterized by continuity evidenced in long periods of stasis where there were only modest changes alternating with discontinuity where there were short periods of rapid change that they labeled *punctuated equilibrium*. The implication was that there was a balance

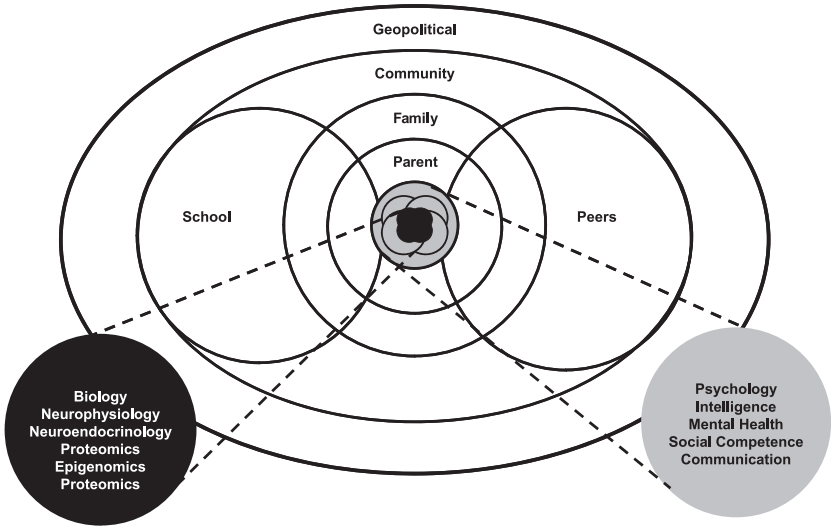

Figure 6. Biopsychosocial ecological system.

between species and their ecosystems until it was interrupted by either large changes in the species or large changes in the environment that required a new equilibration. In terms of understanding developmental discontinuities in the individual, we would need to search for such changes in the child or the context that create pressures for a new equilibration. These forces are represented by the up and down arrows around points of inflection in Figure 7.

One of the most commonly accepted transitions has been the 5- to 7-year shift in cognition originally documented in 21 behavioral domains by White (1965) and accentuated in the work of Piaget. Thirty years later Sameroff and Haith (1996) and a group of contributors reexamined this transition but also asked if there were contextual changes during this age period. We reached the conclusion that there was a 5- to 7-year shift in the child if by 5 we meant 3 and by 7 we meant 10. This answer reflects the study of what might be called ''part processes.'' If one asks whether 5-year-olds can attend, remember, have emotions, engage in social interactions, and even take charge of social interactions, the answer is yes. If one asks whether 5-year-olds can fully integrate their physical, cognitive, emotional, and social worlds, the answer is no. But neither can 7-year-olds. So what is the punctuation between the ages of 5 and 7? On average 5- to 7-year-olds can integrate several behaviors that permit the beginnings of formal education in most cultures in the world—increased cognitive ability, the ability to sit still, and the ability to pay attention. Some children have these capacities much earlier, but the requirements for successful participation in the school setting require all three plus a number of others. White's (1996) more recent conclusion was that, ''what happens to children between 5 and 7 is not the acquisition of an absolute ability to reason; it is an ability to reason with others and to look reasonable in the context of society's demands on the growing child to be cooperative and responsible (p. 27).'' In Figure 7 there are up arrows from self to other reflecting child advances, but there may be more powerful influences from other to self where society does the developmental punctuation by requiring the child to spend most of the day in school rather than at home. From this perspective the stages of infancy, childhood, adolescence, and adulthood could be

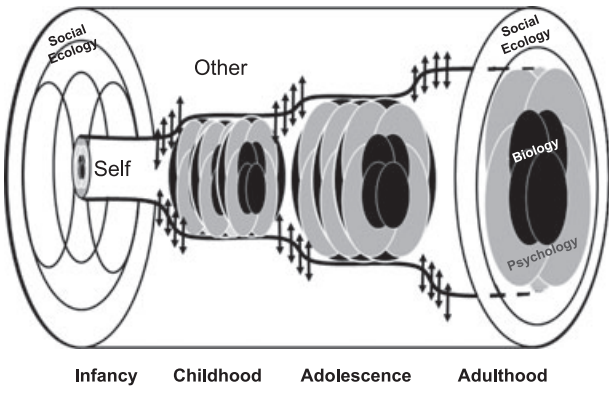

Figure 7. Unified theory of development including the personal change, context, and regulation models.

relabeled the home stage, the elementary school stage, the secondary school stage, and the work and new family stage.

Similar analyses can be applied to the punctuations that occur in the transition to adolescence or adulthood. It is the relation between shifts in the child and shifts in the context that mark new stages. Puberty is a biological achievement of the child but adolescence is a socially designated phase between childhood and adulthood (Worthman, 1993). Puberty is universal but adolescence is not, either in historical or cross-cultural perspective. In many cultures adolescence is directly tied to biological changes but in modernizing cultures it is more closely tied to age-based transitions into middle and high schools. Depending on the culture sexual participation can be encouraged at an early age before biological maturity or discouraged until individuals are well into adulthood. These pressures from changes in the child and the context are represented by the up and down arrows around the adolescent transition in Figure 7. In western societies, adolescence is generally recognized but the quality of the adolescent experience is quite variable and may be heavily dependent on stage–environment fit. Depending on the particular family or school system, desires for autonomy and intimacy can be fostered or thwarted moving the adolescent into better or worse future functioning. Negative psychological changes associated with adolescent development often result from a mismatch between the needs of developing adolescents and the opportunities afforded them by their social environments (Eccles et al., 1993).

The unified theory depicted in Figure 7 combines the personal change, contextual, and regulation model, but it would become overly complex to add the representational model to the figure, as well. Suffice it to say that representation suffuses every aspect of the model in the interacting identities, attitudes, beliefs, and attributions of the child, the family, the culture, and the organizational structure of social institutions. Moreover, the way developmental science conceptualizes the child may be only one of a number of possible cultural inventions (Kessen, 1979). The most important representation for current purposes is captured in the depiction of a unified theory of development. Like most theories the unified view does not make specific predictions but does specify what will be necessary for explaining any developmental phenomena. It is a reversal of the usual bottom-up empirical stance where the researcher maintains as narrow focus as possible unless forced to enlarge the scope by some contradictory findings. The top-down theoretical stance is that researchers need to be aware that they are examining only a part of a larger whole consisting of multiple interacting dynamic systems.

Future of Nature Versus Nurture

Current Nature Ascendance

The current ascendance of research using new biological measures of individual differences is the result of the interdisciplinary collaboration that Parke (2004) had indicated was essential to the advance of developmental research. These advances in molecular genetics, endocrinology, and neurology are being rapidly integrated into psychological research. The good news is that the new science is no longer based on the reductionist models of the past where linear progressions were proposed between biological entities such as genes or neurotransmitters and psychological function. In each domain multidirectional models are replacing unidirectional ones with a growing emphasis on gene–environment interactions, epigenome–experience transactions, and brain plasticity. These advances are relationship based, requiring increasingly complicated systems analyses to capture the multiple part–whole processes underlying developmental change. Nurture, for example, the environment of the gene, the environment of the cell, and the environment of the organism, are incorporated into advanced analyses of the contribution of context at every level of analysis. It is striking that the nonreductionist systems thinking that those who define psychology as a natural science have avoided is a now a central part of their colleague disciplines of biology and physics. Developmental science is benefiting from advances in the natural sciences at the theoretical as well as the empirical level.

Next Resurgence of Nurture

A renewed emphasis on the importance of nurture is underway. Again, it is a dialectical result of the inability of appeals to human nature to explain fully developmental pathways. There remain large amounts of unexplained variance. The nurture resurgence is implicit in the new directions for biological sciences such as epigenomics, described above, and will become explicit with a more powerful appreciation of the perspectives on human development provided by social sciences beyond

psychology. The core element in each interdisciplinary effort is that successful developmental predictions from psychological measures are highly contingent on the social or biological context. Two of the major ingredients needing integration into a unified developmental science are the *opportunity structure* construct from sociology and economics and the *meaning making* construct from anthropology.

The important perspective that sociology adds to developmental science is that individuals are embedded in networks of relationships that constrain or encourage different aspects of individual behavior. Social institutions like families, schools, and the workplace are composed of roles that children come to understand and fill. In this view individual differences, the core of psychological concern, are limited by role demands in predicting developmental outcomes. Economists are interested in what keeps economies going and individual behavior is viewed through the lens of financial choices. The part of economics most relevant to behavioral development is the availability of an opportunity structure. Once again the predictive power of individual differences is constrained by the availability of such resources as educational systems, job choices, and social mobility that determines whether individuals have the option to use their prior competencies or not. Anthropology is indeed interested in cultural differences in behavior, but equally important for understanding development are differences in meaning systems, that is, how different cultures think about their practices. The same behavior can have quite different meanings and quite different behaviors can have the same meaning in different cultures. Again the predictive power of individual differences is constrained by how different cultures value and proscribe different behaviors.

Development of the Developmentalist

I began this article proposing that the study of the development of our field would illuminate our study of the development of individuals. Up until the 1960s *child psychologist* was the predominant label for researchers with children and the main focus was on identifying measures of stable intelligence and personality traits that would be predictive of adult performance. In the 1960s and 1970s we became *developmental psychologists* as organizational principles and emergents dominated the rhetoric around the cognitive revolution and attachment theory. During the 1980s and 1990s we reframed ourselves as *developmental scientists* when we gained a fuller appreciation of the contribution of biology and the social ecology to psychological growth. In the new millennium we again are changing our self description to *developmental systems theorists* as multilevel biopsychosocial dynamic systems are becoming the framework for understanding human change over time and statisticians are providing tools that are closer approximations to the complexity of our data.

With regard to what we have learned about nature and nurture, the future challenge is not to find new arguments for one or the other but to create a developmental model where advances in the study of both individual and context are expected and hoped for. I have proposed such a biopsychosocial unified theory of development that I hope will be useful for future research in human development. Over time the body changes, the brain changes, the mind changes, and the environment changes along courses that may be somewhat independent of each other and somewhat a consequence of experience with each other. It should be a very exciting enterprise to fill in the details of how biological, psychological, and social experiences foster and transform each other to explain both adaptive and maladaptive functioning across the life course.

Coming full circle to the dialectical principles of the yin–yang model, there are continuities as scientists concerned with greater differentiations within our biological and social experience continue to push our understanding of both nature and nurture. But there are increasing discontinuities with the rhetoric of the past as many more developmentalists realize that neither nature nor nurture will provide ultimate truths and neither can be an end in itself. Instead, each can explain the influences of the other because in the end neither can exist without the other. They mutually constitute each other through their unity and interpenetration of opposites. The schematic depiction of the unified theory of development provides an integrated way of looking at things, but also for things. Although we all have a strong desire for straightforward explanations of life, development is complicated and models for explaining it need to be complicated enough to usefully inform our understanding.

> Everything should be as simple as possible, but not simpler.
>
> Albert Einstein

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