1 Developmental Science: A Collaborative Statement

The Carolina Consortium on Human Development

Developmental science refers to a fresh synthesis that has been generated to guide research in the social, psychological, and biobehavioral disciplines. It describes a general orientation for linking concepts and findings of hitherto disparate areas of developmental inquiry, and it emphasizes the dynamic interplay of processes across time frames, levels of analysis, and contexts. Time and timing are central to this perspective. The time frames employed are relative to the lifetime of the phenomena to be understood. Units of focus may be as short as milliseconds, seconds, and minutes, or as long as years, decades, and millennia. In this perspective, the phenomena of individual functioning are viewed at multiple levels – from the subsystems of genetics, neurobiology, and hormones to those of families, social networks, communities, and cultures.

We believe that recognizing the complexity of development is the first step toward understanding its coherence and simplicity. In this perspective, patterns of adaptation represent interactions across levels within and without the person. Because the relative weights of these contributors to behavior vary across ontogeny and across domains, longitudinal analyses have particular value in understanding how they are coalesced over development. The pathways of development are relative to time and place; they contribute to – and reflect – temporal changes in culture and society. Developmental investigation focuses attention on the ontogenies of both embryos and ancestors, and on the process by which pathways may be repeated or redirected across successive generations. Toward this end, comparative, cross-cultural, and intergenerational research strategies should be employed in conjunction with standard experimental methods.

The preamble to this chapter summarizes our consensus on the scope and concerns of developmental science. In this volume, we elaborate on the propositions embedded in the preamble and explore their implications for scientific research and social applications.

Developmental science has roots in both the biological and social disciplines. The need for a systematic developmental perspective has long been recognized in comparative psychology and behavioral biology. Fresh statements of this kernel assumption have recently evolved in developmental psychobiology, dynamic systems approaches, and models of neurobehavioral development.[1] Simultaneously, the need for a developmental approach to the social and cognitive phenomena was expressed in the work of Baldwin (1897), Cottrell (1942), Piaget (1926), Lewin (1931), and Vygotsky (1962). Over the past two decades, these ideas, too, have been extended and elaborated in social ecology, social development, cognitive development, and life-course analysis.[2]

The modern developmental orientation – including the term "developmental science" itself – has won reasonably broad acceptance over the last decade. Nonetheless, shortcomings remain in attempts to translate it into an effective program of research, training, and application. Part of the problem appears to be the inertia of traditional disciplines and the rigidity of existing research boundaries. To the extent that ideas remain at an abstract level, they do not demand a reorientation of existing academic disciplines and separate domains of knowledge. On this score, advances in scholarship typically precede changes in institutional structure. The study of development is no exception. Discipline and institutional barriers are deeply rooted, and the gap between biological-health training and behavioral-social training has proved difficult to bridge.

A second part of the problem has been the demands of the orientation upon the individuals who aspire to conduct holistic developmental study. To support the concept of interdisciplinary research is one thing; to expect that individuals will embrace and teach the concepts in areas beyond those in which they themselves were trained is another. Not only must oppor-

[1] The pioneers in the embryology of behavior and behavioral biology include Kuo (1967), Schneirla (1966), Weiss (1939/1969), and von Bertalanffy (1933/1962). Beyond the chapters in this volume, introductions to recent developments in behavioral biology could include, for instance, developmental psychobiology (e.g., Gottlieb, 1992; Hood, Greenberg, & Tobach, 1995), ethology (e.g., Bateson, 1991; Hinde, 1966), dynamic systems approaches (e.g., Thelen & Smith, 1994; Smith & Thelen, 1993), and developmental neurobiological approaches (e.g., Magnusson, 1996).

[2] Beyond the chapters in this volume, see, for example, statements on social ecology (Bronfenbrenner, 1979; Sameroff & Fiese, 1990), social development (Cairns, 1979; Cairns & Cairns, 1994; Eckerman, 1993a; Magnusson, 1988; 1995), cognitive development (Valsiner, 1987), and life-course analysis (Elder, 1995; Moen, Elder, & Lüscher, 1995).

tunities and facilities for such training be provided, but the candidates and the faculty must be highly motivated to attain skills that go beyond a single discipline.

The perspective is still evolving. The orientation demands a fresh look at research design and analysis. Without a thorough reexamination of methodology and analyses and their relations to theory, investigators may become, unwittingly, attracted to procedures that are ill-suited for studying developmental processes. In this regard, some of the more rigorous experimental designs, measures, and statistics in psychology characteristically control for (or eliminate) variance attributable to age changes or maturational differences. In contrast, the developmental perspective requires research methodologies and analyses that promote the study of ontogenetic integration across levels and over time.

Then there are the issues of the breadth of the time intervals studied and the scope of their measurement. Attention to time intervals brings attention to the possible time-boundedness of observations in a given society. Temporal changes within a culture can invalidate even the most carefully framed generalizations about behavior and social processes, to the extent that these generalizations have been restricted in time and place. But temporal change should not be seen simply as a handicap, as it has sometimes been viewed within psychology. Within the present framework, these temporal shifts are employed to clarify the developmental mechanisms at work and demonstrate their operation in concrete instances of adaptation. One mediating link between ontogenetic and temporal-generational study can be found in the detailed analysis of the processes of intergenerational transmission and intergenerational change.

Magnusson (1988) has called for longitudinal research designs that accurately reflect the integration of processes within individuals and sequential changes over development. Person-oriented as well as variable-oriented analyses should be employed to track individuals over successive ontogenetic stages. To ensure that the hard-won gains in statistical rigor and empirical objectivity are not compromised, precise linkages must be established with traditional methods of statistical analysis. Where differences appear, the reasons for the differences must be carefully explored and their implications monitored (Magnusson & Bergman, 1990).

Issues of human development are central to modern society. Each stage of developmental progress presents special problems for adaptation and health. For example, adolescence is characterized by asymptotic levels of automobile accidents and personal injuries, including those caused by violent crime. It is also the period associated with the onset of drug and alcohol

addiction and with a sharp increase in self-destructive behavior. The school failures and drop-out rates of adolescents are directly linked to earlier identified problems in their academic performance and motivation, including specific disabilities in reading.

Adolescence cannot be viewed, however, independently of the stages of development that precede it, nor can it be divorced from later life stages or from the transmission that occurs from one generation to the next. Problem behavior in adolescence is usually continuous with problem behavior in childhood, but it also shapes life chances for the adult years. Such pathways of development constitute a critical part of the story of how behavior patterns are transmitted across generations. Behaviors in childhood may or may not persist into the years of childbearing and child rearing. In order to plot across-time linkages, longitudinal studies of individuals, families, and social groups are required. The longitudinal research design has become recognized as critical for understanding the diverse issues of development, education, and health.

Developmental trajectories occur in changing worlds. There is good reason to expect that people mature and age in different ways according to these changes. Indeed, there are dramatic modifications worldwide in the structure of the family, in the economic support available to children, and in the perceived responsibilities of adults for their aging parents. An adequate account of families requires attention to intergenerational social bonds, including those established between grandparent and grandchild, as well as to parent-child relationships. Virtually every index on trends in American society indicates that changes in family structure will continue unabated into the next century. Behavioral and social investigations have been unable to keep pace with these family trends, despite the dire implications of some of the changes. The costs to society of providing for alternative care, child health, and education will multiply over the next decade. But if the decisions are based on inadequate knowledge, the costs will be even greater.

Although human development is a central issue in this volume, we recognize that an understanding of developmental processes necessarily involves study that is multilevel and integrated. This is in accord with Kuo's (1967) proposal that "The study of behavior is a synthetic science. It includes comparative anatomy, comparative embryology, comparative physiology (in the biophysical and biochemical sense), experimental morphology, and qualitative and quantitative analysis of the dynamic relationship between the organism and the external physical and social environment" (p. 25). Kuo himself studied animals, and several of us who contributed to this volume have focused on nonhumans in our research.

Others of us focus on social, emotional, and cognitive processes in humans. Together, we concur that the "synthetic science" of development should be inclusive rather than exclusive. A distinctive feature of this volume – and the Carolina Consortium discussions that led to its production – is the belief that developmental constructs that have emerged from social and cognitive research in humans can be productively merged with constructs from research on animals and basic processes in infants. We also believe that confrontation can lead to clarification and advances in understanding when the inquiries are open and friendly, when one's colleagues are held in the highest regard, and when the group is bound together by a common, compelling goal. It was in this spirit that the present volume was prepared.

One may question whether the study of young organisms is sufficient reason for the definition of a new science. But the question itself is misleading, in that the essential concerns of development are not limited to children. Development encompasses the entire manifold of the life course, from conception to death, and into the next generation. Children become parents in their own time, and novelties introduced in one generation can become the traditions of the next.

This view of development requires concepts and measures that permit the description of persons-in-context through time and space. We see individuals as integrated and integrating units that are dynamic and change over time. This proposal is in conflict with a reductionistic view that the adaptations of persons could be partitioned into separate variables and elementary units of behavior or biology, and removed from the whole for independent analysis. In the developmental framework that we have adopted throughout this volume, the biologies and actions of persons are mutually constrained over time. The emerging holistic view has multiple consequences for research design, measurement, and analysis.

This latter point is a relevant response to the criticism that the introduction of developmental concepts may be a step backward because of the complexity that is introduced. We disagree. In our view, recognition of the complexity of behavioral development has been, paradoxically, a key to achieving both greater accuracy and parsimony in measurement. By omitting developmental and contextual considerations, traditional psychological models have tried to solve the puzzles of behavior with less than half of the pieces on the board. Allowing more information into the system – including details about ontogeny and context – provides components that are essential to understanding how persons adapt to the concrete realities of life.

What has been new in the last two decades has been the emergence of the

results of detailed prospective longitudinal studies of human beings. These findings have forced the reevaluation of traditional conceptions of behavioral functions and of how these functions are organized over time in children, adolescents, and adults. They have also provided new solutions to the problem of how behaviors are organized in context. This concrete information on development has become wedded to psychobiological constructs of ontogeny, and the synthesis that has emerged has in turn created pressure for radical change in traditional measures, designs, and constructs.

The statement on the scope and limits of developmental science provided here is an introduction to the issues addressed in this volume. It was given its preliminary form during discussion and debate among the faculty and fellows of the Carolina Consortium on Human Development. It is a statement that continues to evolve, and the nature of this evolution is reflected in the chapters that follow.

2 Developmental Science: Toward a Unified Framework

David Magnusson and Robert B. Cairns

A fresh synthesis of ideas and findings has recently emerged across the several areas of developmental investigation. As indicated in Chapter 1, this synthesis employs concepts that have issued from longitudinal investigations, life-course studies of contextual change, cognitive development, and developmental psychobiology. Consistent with the collaborative statement, the stuff of development is seen as arising from the dynamic interrelations among systems that exist within and without persons. A nuclear principle of this holistic framework of development is that "the individual is an active, purposeful part of an integrated, complex and dynamic person-environment system. A consequence of this view is that it is not possible to understand how social systems function without knowledge of individual functioning, and it is not possible to understand individual functioning and development without knowledge of the environment" (Magnusson & Stattin, in press). Accordingly, development is not simply a property of individuals – social interactions develop, communities change, and societies evolve. In this chapter, we summarize some principles that provide a bridge between the conceptual framework of developmental science and the concrete methods required for the conduct of developmental research.

In the consensus statement in Chapter 1, we observed that "recognizing the complexity of development is the first step toward understanding its coherence and simplicity." The problem has been that it has been difficult for researchers to move beyond the first step. Accordingly, the holistic perspective described in the collaborative statement presupposes multidisciplinary methods and multilevel measures. These procedures are required to analyze the integrated operation of bidirectional and correlated systems across levels of influence. A developmental orientation implies that observations should be extended over time and generations in order to plot the mechanisms and rates of change and to identify developmental pathways that are formed for persons and contexts.

What Develops?

Given the current state of research in behavioral science, it is clearly beyond the scope of any single researcher to investigate simultaneously all of the systems that contribute to behavioral adaptations. Choices have to be made, and the question "What develops?" must be addressed at the beginning of any investigation. Does the problem involve time-related changes in social behavior, perception, neurobiology, communication, disease processes, social networks, or cultures? The dilemma is that these systems simultaneously undergo changes over time, and together they contribute to the social and adaptive functioning of persons and societies. However, in order to achieve precision in empirical analysis and understanding, decisions must be made to bring some features to the foreground and move others into the background. Developmental researchers trained in neurobiology and genetics inevitably adopt different starting points in their investigations than, say, those trained in life-course sociology and anthropology. And this decision on where to begin has inevitable consequences for what kinds of specific generalizations will first emerge.

This volume illustrates the point. Elder (Chap. 3, this volume) demonstrates that generational changes in society provide a window for understanding how environmental changes help produce modifications in family processes and individual development. In contrast, Gottlieb (Chap. 4, this volume) shows that the sensory and perceptual development of the embryonic or neonatal organism provides a productive entry for understanding the bidirectional developmental system. But it is also clear from both Gottlieb's and Elder's chapters that the authors consider the developmental analyses incomplete without explicit accounts of interactions with systems above, or below, the points of entry that they selected. Parallel accounts of convergence, despite different starting points, are found in each chapter of this volume. This is illustrated in comparisons between the social-communication concerns raised separately by Eckerman and Tudge, Putnam, and Valsiner, and the biobehavioral issues raised in companion chapters by Gariépy and Sameroff and Suomi. Morrison and Ornstein raise the issues of developmental pathways in the analysis of cognitive processes, while Costello and Angold speak to a comparable concern in understanding the development of psychopathology.

Differences in starting points should not, therefore, obscure the common ground upon which developmental research proceeds. To this end, we believe that it should be helpful to summarize certain of the assumptions shared by virtually all developmental investigators regardless of their spe-

cific area of expertise. The common goal is to understand how the multiple systems that influence individual development – from cultural processes to genetic and physiological events to social interactions – become integrated over time to promote healthy, adaptive functioning or its converse. The orientation is developmental because of a shared concern with the emergence, dynamics, and pathways of change of component systems and of individuals as a whole. Essential developmental questions include how interacting systems influence each other and are brought into alignment over time.

"Coming of Age": Developmental Integration over Time and Space

To illustrate the developmental research strategy, consider the findings from recent longitudinal investigations into the relationship between early pubertal maturation and attitudes and behaviors (Caspi, 1995; Caspi & Moffitt, 1991; Stattin & Magnusson, 1990). In brief, the research indicates a link between developmental changes in rates of maturation, social relationships, and deviant behaviors. Specifically, very early maturation in girls is associated with a variety of deviant behaviors, and this relationship is mediated by the effects of differential affiliation in the girls' social networks.

In a longitudinal investigation of 1,300 Swedish children, Stattin and Magnusson (1990) reported that the girls who reached menarche very early (≤ 11 years of age) tended to show multiple signs of behavioral deviancy. Deviance among these very-early-maturing girls included, at 14 years of age, higher alcohol consumption, more cheating in school, greater amounts of sexual activity, and adoption of antisocial norms relative to the attitudes of late-maturing girls at the same age.

Following a developmental model, these investigators (Magnusson, 1988; Stattin & Magnusson, 1990) reasoned that the effects may have been mediated by social interchanges that were provoked and supported by the early maturation. The girls affiliated more with older peers and adopted developmentally advanced actions and values. The result was that their sexual and social behaviors deviated, for a 15-month period, from age-appropriate standards. Support was obtained in the IDA longitudinal data set for this maturation-affiliation-activity interpretation (Magnusson, 1988; Stattin & Magnusson, 1990). Consistent with the hypothesis, this effect was observed only among early-maturing girls who had affiliated in early adolescence with older males who were out of school and working.

More broadly, it is not merely the rate of onset of sexual maturity that accounts for the prediction of deviance in adolescence. To the contrary, a key mediational variable appears to be the social affiliations that were promoted by the biological changes. It should be emphasized that the specific deviance–pubertal onset relationship was limited to the years of mid adolescence. By age 15, most differences in deviance had diminished. When later-maturing girls reached a similar state of sexual maturity, no differences were observed in female antisocial behavior as a function of rate of maturation. But a follow-up in adulthood showed that some effects associated with early maturation still persisted. The very early-maturing girls had married earlier, had more children, and had achieved less advanced education relative to the average or late-maturing girls.

Essential features of these findings have been replicated in other settings and with other samples. For instance, Caspi and Moffitt (1991) found the same early maturation–deviance phenomenon in the longitudinal study of a sample of New Zealand girls. The effect was obtained, however, only if the girls were enrolled in a coeducational school. Presumably, the opportunities for deviance by differential association were greater in the coeducational setting than they were in all-girl schools.

Such boundary conditions for the maturation-deviance effect point to the role of social context in determining the nature of the phenomenon. Viewed in this light, cross-cultural and cross-generational designs are absolutely required for the systematic developmental study of social interactions. According to Bronfenbrenner (1958), studies of the variations in the effects of child-rearing practices over time and space are critical for understanding the processes of socialization. The same principle doubtless holds for studies of the maturation-deviance effect. In a holistic framework, the variations in outcome across societies could reflect context differences in multiple domains. Toward this end, it would be instructive to identify social contexts where early maturation supports differential peer affiliations but does not lead to increased behavioral deviance.

Such contexts occur in the United States. In a longitudinal study of two samples of American youth, Cairns and Cairns (1994) confirmed that girls who matured very early tended to hang around with other girls who also matured very early.[3] But very early sexual maturation was *not* associated with subsequent problem behaviors. In the American samples, age of men-

[3] In this investigation, "very early" referred to girls who reached menarche between 9 and 11.5 years of age. The mean age of menarche was 12.6 years of age in the combined U.S. samples, virtually identical to the mean reported by Magnusson (1988) in his Swedish sample.