On the use of longitudinal research in developmental psychology

DE RIBAUPIERRE, Anik

Epilogue: On the use of longitudinal research in developmental psychology

ANIK DE RIBAUPIERRE

In this epilogue chapter, I will focus on the key points of the book: the issues of developmental transitions (that is, changes as defined by the different authors), of the change or transition mechanisms that have been hypothesized, and of the relevance of a longitudinal perspective. Because the general criterion of a longitudinal-developmental design is repeated individual observation (Baltes & Nesselroade, 1979; Hoppe-Graff, this volume), allowing a study of inter- and intraindividual differences over time, the review will also devote special attention to the role assigned by the authors to individual differences in development.

The chapter begins by calling for a clearer definition and distinction of concepts such as developmental changes, transition principles, and transition mechanisms; then the different content chapters of the book will be briefly reviewed, according to the authors' explicit or implicit definition of transitions and of underlying mechanisms, the role of individual differences, and the specificity of a longitudinal approach. Finally, the scarcity of longitudinal research will be discussed; I will argue, in particular, that its main cause does not lie in practical difficulties as is often mentioned, although they are real, but rather in conceptual problems and in the clear lack of interest for individual differences manifest in developmental psychology at large.

About transitions and transition mechanisms

A transition in its most general meaning implies the passage or change from one state to another. Hoppe-Graff in his introductory chapter specifies that a transition is a change in a well-defined developing system. It therefore requires that one clearly define the states or endpoints under study and describe the intervening changes or transitions; only then can inferences be drawn as to the factors or mechanisms of transition. I see three levels of analysis and inference on the basis of observed performances, from the more descriptive to the more inferential.

First, an important descriptive enterprise has to be conducted at a
intrinsic constraints on development and account for the range of performances possible at a given level (Campbell & Bickhard, 1986) and for developmental sequences of abilities across domains. This step corresponds to what Flavell and Wohlwill (1969; Flavell, 1984) labeled the formal or morphological aspect of any account of development. Indeed, a basic "structuralist error" (e.g., Campbell & Bickhard, 1986; de Ribaupierre & Pascual-Leone, 1984) has often consisted in considering task descriptions as accounts of internal processes and representations.

The third level consists in defining underlying processes as well as mechanisms of transition — that is, in trying to understand how and possibly why one proceeds from one state to the other. This step requires still greater inferences because mechanisms as such are just never observable. A whole range of mechanisms has been defined in the literature, more or less finely differentiated. For instance, Flavell (1977; 1984) distinguishes between those processes operating within cognitive entities such as differentiation and those processes relating different cognitive entities, such as integration, subordination, coordination, regulation, and equilibration. A further obstacle to a clear consensus in the literature with respect to the term mechanism, already alluded to with respect to the status of the stage concept, resides in a frequent confounding between external and internal variables. I suggest reserving the terms transition processes and/or mechanisms to psychological or organismic variables; as an example, the Piagetian concepts of assimilation, accommodation and equilibration (whatever their operationalization may be) can be seen as true organismic processes. These should be clearly differentiated from external or environmental variables that, even though they may have a causal influence, need to be mediated through some psychological variable. The psychological variables could be referred to as transition factors. For instance, accounts of the influence of socioecono- mic variables on cognitive development remain purely descriptive as long as one does not try to understand through which psychological processes such external variables are necessarily mediated (e.g., Lautrey, 1980). Another example is the interesting distinction introduced by Rutter (in press) between risk indicator and risk mechanism, the latter being considered as more remote and exerting a causal influence; however, such mechanisms still seem to correspond to external variables, and there remains the need to understand with which internal mechanism they may interact.

This is not to say that only internal or subjective mechanisms should be focused upon; on the contrary, I am arguing for a better differentiation between internal and external variables, which in turn should lead to a better understanding of interactional or transactional phenomena. Keeping with Hoppe-Graff's (this volume) useful distinction, I would
consider transition principles (defined by Hoppe-Graff as laws of change) as referring essentially to the observer's descriptive account of the developmental changes, whereas the term transition mechanisms (defined as those principles explaining the transition) could be reserved to describe organismic variables and changes. A good example of a transition principle from the observer's point of view is provided by Fischer's transformational rules (Fischer & Lamborn, this volume), whereas an example of an organismic variable accounting for developmental change could be found in Pascual-Leone's M-Power (e.g., Pascual-Leone, 1970, 1983, 1987) or Case's Short Term Storage Space (e.g., Case, 1985).

I would like to argue that the issue of psychological internal processes versus external variables is even more problematic when it comes to individual differences in cognitive development, which are crucial when a longitudinal perspective is adopted. Indeed, developmental psychologists increasingly acknowledge the importance of individual differences (e.g., Case, Marini, McKeough, Dennis, & Goldberg, 1986; Fischer & Silvem, 1985; Neimark, 1985); however, the source of individual differences is most often located outside the subjects, such as in tasks, environments, or at best in the subjects' past experience. In turn, these nonorganismic variables are considered to modulate a developmental process that remains essentially conceptualized as unidimensional (for a discussion, see Dasen & de Ribaupierre, 1987; Lautrey, 1985; Pascual-Leone, 1987; de Ribaupierre, Rieben, & Lautrey, 1988; Rieben, de Ribaupierre, & Lautrey, 1986, 1988).

Because the necessity and the specificity of longitudinal studies have been well analyzed by Hoppe-Graff, in the introduction, they do not need to be discussed in detail again. The objectives of a longitudinal design, relative to a cross-sectional design, may be seen as threefold: the very simplistic and not exhaustive classification that follows will be used to review the chapters.

First, one can hope to obtain finer descriptions of change by following the same subjects over time. The conservation paradigm described by Piaget in terms of regulations can be taken as a sketchy example: Piaget claimed, on the basis of cross-sectional studies, that subjects start by centering on one dimension, then on the other, and finally on the two together. One could hope that such shifts could be observed longitudinally. However, such a hope remains in most cases idealistic, because not only does it raise the issue of observability of changes (e.g., Hoppe-Graff, this volume), but the study would require microlongitudinal studies, which for many reasons are unfeasible on a long period and with such paradigms. Further, the specificity of a longitudinal design is not optimized in such an approach; the same results could probably be obtained via cross-sectional studies, provided a very small age interval is used. In the same vein, and somewhat paradoxically given the reasons usually given for not resorting to a longitudinal design, longitudinal studies may be used for practical purposes, particularly in infancy research: The same babies are seen several times because it is more convenient for a variety of reasons. Once more, the specificity of a longitudinal design (i.e., of intraindividual repeated measurement) is not well exploited. A second objective of longitudinal studies, mainly used in personality and in clinical research and more often in studies covering the life-span than in developmental child psychology (although there is no reason for that but for a different focus of interest), lies in their predictive power. The interest here is to understand which may be the best predictors of a number of behavioral outcomes; in terms of psychopathology for instance, retrospective studies are certainly not sufficient for understanding the causal chain leading to a maladaptive outcome (see Rutter, in press).

A third objective of a longitudinal design is model testing. Usually, hypotheses are first derived from cross-sectional studies and the longitudinal design serves to test them, in terms of the developmental function of and in terms of individuals, in particular by evaluating whether changes defined in terms of groups (age differences) also apply to individual subjects (intraindividual developmental changes). This is the approach that Schneider and Weinert (this volume) refer to as deductive. Note that, as will be later discussed, this approach requires that the researcher be convinced of the necessity to study individual differences; as long as one postulates universal developmental trends, the cost of longitudinal research may appear too great. It is, however, the only means to assess whether development takes the same form for all subjects.

Review of papers

As mentioned previously, this section will overview the different chapters dealing with content areas, focusing on the developmental end states and forms that are implicitly or explicitly defined by each author, the transition principles, mechanisms or factors that are hypothesized, the meaning assigned to individual differences, and the relevance of a longitudinal perspective. Because few authors explicitly spell out these different aspects, this review will necessarily be very sketchy and may reflect gross misinterpretations on my part with respect to which I ask for the authors' indulgence. A summary of these points is presented in Epilogue Table 1.
<table>
<thead>
<tr>
<th>Developmental end state</th>
<th>Transition principles</th>
<th>Transition mechanisms</th>
<th>Role of longitudinal studies</th>
<th>Role of individual differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fischer and Lamborn</td>
<td>Tiers Levels Steps</td>
<td>Transformation rules: shift of focus, compounding, substitution, differentiation, intercoordination</td>
<td>Optimal level Emotions Task Environmental support</td>
<td>For model testing (implicit) Inter- and intraindividual differences</td>
</tr>
<tr>
<td>Schneider and Weinert</td>
<td>Increment in memory performance Continuous increment (?)</td>
<td>Basic capacities Strategies Content knowledge Metamemory</td>
<td>For model testing: focus on individual curves and on relative contribution of each source</td>
<td>Inter- and intraindividual differences</td>
</tr>
<tr>
<td>Camaioni</td>
<td>Prelinguistic-linguistic One-word utterance and use of syntax Continuity from sociointeractive to linguistic patterns Rhyming, reading, phonological awareness</td>
<td>Interactions Imitation exchanges Activity</td>
<td>For model testing and to determine precursors</td>
<td>Interindividual differences (in rhythm) Intergroup comparisons</td>
</tr>
<tr>
<td>Bryant and Alegria</td>
<td>Nonreading-reading Biological factors as mediated through self-perception and interpersonal relationships</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stattin and Magnusson</td>
<td>Nonproblem–problem social behavior</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harris</td>
<td>Three levels from behavioral expression, acknowledgment of ambivalence, and display Development of two systems of appraisal</td>
<td>Environmental amplification of behavior’s variations</td>
<td>To test stability of relative speed of development and to establish precursors</td>
<td>Interindividual differences (in speed)</td>
</tr>
<tr>
<td>Attili</td>
<td>Development of expression and acknowledgment of ambivalence Progressive integration of internal working models</td>
<td>Cognitive capacities as imposing constraints on development of emotions</td>
<td>For model testing</td>
<td>Interindividual differences (in vulnerability)</td>
</tr>
<tr>
<td>Hofsten</td>
<td>Development of perception-action systems such as reaching and manual coordination Breaking up of the extension synergy Sensitivity to binocular disparity Uncoupling head-arms Stability of upper trunk</td>
<td>Maturation Biomechanical constraints Environment and practice</td>
<td>To disentangle developmental function and developmental change</td>
<td>Interindividual differences (in speed)</td>
</tr>
<tr>
<td>Bloch</td>
<td>Development of early coordinations Stability Increasing accuracy Regressions</td>
<td>Difference in the maturational level of the different components Biomechanical constraints Patal development Experience</td>
<td>For model testing (form of development and continuity–discontinuity)</td>
<td>—</td>
</tr>
<tr>
<td>Butterworth</td>
<td>Prenatal–postnatal coordinations Stabilization Labilization Regression Disappearance Substitution Integration</td>
<td>Biomechanical constraints Cognitive changes</td>
<td>For model testing (continuity)</td>
<td>—</td>
</tr>
</tbody>
</table>
Fischer and Lamborn's essay will be discussed in somewhat greater length than the other papers because it proposes a general model of cognitive and emotional development or a "big picture" of development to use Flavell's term (1984), applied in the present case on the development of social interactions (honesty and kindness). The model focuses on the development of skills throughout childhood and adolescence, and defines three types of levels, from the more general to the more specific: tiers (i.e., main stages), recurrent levels within each tier, and steps within levels. Thus, the model provides for clearly defined and illustrated developmental products or end states, throughout a large developmental range, starting at birth and ending at adulthood (although the present chapter deals mainly with late childhood and adolescence). The distinction between surface and deep structures or mechanisms (i.e., between actual performances and underlying mechanisms) is, however, not always clearly stated in Fischer's model (see also Dasen & de Ribaupierre, 1987). As a consequence, the term level seems to refer interchangeably to the observable performance and to the underlying "competence": For instance, optimal level is seen as a "process affecting the complexity of skills" (deep level) and as an observable level of performance reached under high environmental support. Likewise, functional level refers to the highest observable behavior in spontaneous contexts where no environmental support is provided, and it reflects the child's underlying competence in that context (Fischer, personal communication).

Transition principles or laws accounting for the sequence of skill acquisition are described in terms of transformation rules, two of which are analyzed in greater detail in the present chapter, namely, shift of focus and compounding. In other papers (e.g., Fischer & Pipp, 1984), three additional rules are hypothesized: substitution, differentiation, and intercoordination. The first four rules deal with within-level sequence of skill acquisition whereas intercoordination is assumed to account for the transition to a higher level as well as to a higher tier. Although they are sometimes described as processes, these rules merely seem to be good descriptions of changes in the observer's language, particularly as they are described as algebraical rewritings. In this sense, they correspond to the second step suggested previously, and not to transition processes. Fischer and Lamborn consider four factors, qualified as "mechanisms that produce change": optimal level, emotions, task, and environmental support, construed as both organismic and environmental. These factors certainly play an important role as sources of variation in performances (and as such are undoubtedly both environmental and organismic); however, to refer to them as psychological processes or mechanisms seems disputable. First, to consider optimal level for instance as a mechanism eradicates the distinction between structures and processes: Structures, as already mentioned at the beginning of this chapter, might constrain a theory of processes but should not be considered psychological realities (see Campbell & Bickhard, 1986). Thus, optimal level may well correspond to a processing limit but is not a process or mechanism in itself. Second, considering these four factors as mechanisms attests, in my opinion, to a confounding between subjective and environmental variables and not necessarily to an interactionist perspective as Fischer would defend. Although entirely subscribing to a perspective stated in terms of interactions—and Fischer systematically and rightly emphasizes, throughout the various presentations of his model, the need to conceptualize development in terms of interaction or collaboration between person and environment—I would like to argue (probably on different epistemological grounds) that a truly interactional approach necessarily rests on a clear distinction between internal and external variables; there are some truly organismic processes responsible not only for developmental changes within the individual but also for individual differences, just as there are some truly external variables, both types of variables being in constant interactions. Environmental support just cannot be seen as a psychological mechanism per se, although it can of course influence development of the structures (informational units) that subjects can elaborate; organismic variables need to be posited, such as an increase in processing resources or limits that in turn will interact with environmental or situational variables to produce developmental changes (or/and individual differences). This is of course not to claim that there are solely organismic influences or purely organismic "types of subjects."

Fischer's model, in contrast to several other neo-Piagetian models, assigns an important role to individual differences; repeatedly in the present essay and elsewhere, the authors say that no across-task invariances can be observed unless performance is assessed under high environmental support. This is indeed a merit of Fischer's position to point to a large individual variability as well as to a large situational variability. "Development does not automatically produce broadly applicable schemes, but involves the construction of skills specific to task domains." I would like to argue again, however, that the distinction between individual differences as psychological or organismic variables on the one hand and environmental variables on the other is not clear enough, due to Fischer's immediate emphasis on a "collaborative" approach.

Fischer and Lamborn discuss methods for testing developmental sequ-
nces; although they point to the usefulness of longitudinal research for providing assessments of different developmental steps in the same individuals, they seem more convinced by the use of a “strong scalogram analysis.” They are correct in suggesting that strong scalogram analysis is not used enough in developmental psychology; they should, however, also note that it is no substitute for a longitudinal approach. As demonstrated by Campbell and Richie (1983; see also Lautrey et al., 1986), within-individuals sequence analysis could yield excellent results (i.e., an excellent Guttman scale could be observed) without there being any common underlying process between the items analyzed. Scale analyses are appropriate for testing the order of items in terms of complexity but are not sufficient for testing developmental sequences. The fact that Fischer and Lamborn have been able to build such well-ordered tasks should not be neglected, however. Longitudinal research would nevertheless still prove necessary to determine whether developmental sequences conform to this order at the individual level—that is, whether subjects follow the ordered tiers, levels, and steps postulated by the authors; furthermore, it would allow analysis of interindividual differences in intrainsidual changes.

Finally, I would like to emphasize that Fischer and Lamborn’s chapter has the merit of integrating cognitive and emotional development. Not only are emotions seen as susceptible to interfere with or to facilitate the cognitive performances, but they are given a cognitive explanation, too: At the beginning of each tier, subjects are seen as more vulnerable, because they are incapable of coping with all the elements at once.

The Schneider and Weinert essay provides an interesting review of work on memory development, and shows that present-day research does not innovate when it attempts to combine the study of general laws and universal developmental functions with that of individual differences. The essay focuses on identification of factors that may cause variations in memory performances but does not define any precise “developmental product”; it addresses the issue of memory increment in general (which, I assume they would probably consider as continuous). This development is not spelled out in detail, probably because until now no invariances have been found across situations; however, the authors mention models such as Case’s that claim to have found such invariances. As a consequence, no transition principle or law describing the changes between end states can be described. However, the Schneider and Weinert essay stresses the three other points that should constitute the focus of the present book—namely, factors causing developmental changes, the importance of individual differences, and the necessity of longitudinal research. Referring to Siegler (1983; 1986; see also Flavell, 1977), they enumerate four sources of change in memory development: basic capacities, strategies, content knowledge, and metamemory. This underlines the need for development to be considered as multidetermined (e.g., Pascual-Leone, 1987; de Ribaupierre, Rieben, & Lautrey, 1988; Rieben, et al., 1986). Not only do they stress this need, but also they argue, on both theoretical and empirical grounds, for the need to assess the relative contribution of each of these sources. Individual differences are also given an important role; it is not always clear, particularly given the role assigned to schooling (i.e., to environmental factors), whether the authors would go as far as considering psychologial organismic factors responsible for individual variability. They also stress the magnitude of variability and, like Fischer and Lamborn, seem to postulate that there is no stability across tasks. Finally, the Schneider and Weinert essay is probably the best advocate of the use of longitudinal studies in developmental research, particularly with respect to its model-testing role; they stress the importance of taking into consideration individual differences, especially when the change in performance is not linear.

Camaioni’s chapter examines the transition from prelinguistic to linguistic behavior, and from early to more elaborate language. The development end states examined are of a behavioral nature and are not described in terms of stages: nonverbal early interactive patterns versus behaviors on linguistic measures on the one hand, and one-word utterances versus emerging use of syntax on the other hand. The transition is described as a progressive shift from person-focused interactions toward increasingly object-focused and “standard action” formats, and a continuity is hypothesized from sociointeractive to linguistic patterns. One of the sources of linguistic development would be interactions and imitation exchanges that allow for shared meanings to be constructed; in turn shared meanings form the referents for more advanced and conventional communications signals, that is, for language. On the basis of her research, Camaioni stresses the importance of activity in conventional games for later linguistic development that would thus be interactively shaped. Action—defined not only as activity on physical objects (aspect stressed by Piaget), but also in a social context—thus plays a major role in the transition. Camaioni also emphasizes the importance of individual differences (defined in terms of rhythm of development and rate of activity) while asserting that only a longitudinal design can help to test the form of developmental transitions.

The objective of Bryant and Alegria’s paper is methodological in that they want to demonstrate the need to combine a longitudinal with an intervention design in order to study developmental transitions and test
any hypothesis of causality. Longitudinal studies are considered to help determine a temporal ordering and a "real life" definite relationship between variables; in contrast, training studies, although they may often be artificial, are considered to allow a hypothesis of causality to be tested. However, the term longitudinal, in Bryant and Alegria's essay, is used too narrowly, because it is equated with correlational designs. If it is true that correlations cannot get at causes, results of longitudinal studies can nevertheless be scrutinized in a more stringent manner—for instance, on the basis of a priori models of developmental changes (e.g., Hoppe-Grall, this volume; de Ribaupierre, Rieben, & Lautrey, 1988). In terms of content, developmental end states are defined as nonreading versus reading, and the focus is on the role of phonological awareness as the source or the result of this change; that is, the paper examines, on the basis of a number of studies, both cross-sectional and longitudinal, whether reading proceeds from phonological awareness or the reverse. It is finally concluded that transition occurs in three steps: some elementary type of phonological awareness such as that which is used in rhyming, then reading, and finally a more elaborated phonological awareness. Because the essay is methodologically oriented, it is relatively difficult for the reader to assume what the authors’ hypotheses are with respect to general underlying mechanisms of transition—that is, with respect to the reasons why at a given age the child is able to categorize words into rhymes or why, besides formal instruction, reading is at all possible.

Stattin and Magnusson's chapter focuses on the emergence of problem behavior in adolescence and on the necessity of longitudinal study for long-term predictions. Developmental end states are defined in terms of behaviors or social "habits," that is, nonproblem versus problem social behavior. Interestingly enough, the problem behavior that is examined (i.e., drinking behavior) is only a problem because of the age at which it is studied, while later on it will be defined for most individuals and within certain limits as a socially acceptable habit. Problem behavior can thus serve as evidence of a transitional state between childhood and adulthood. No transition principles or laws are defined in the essay as to the type of change involved, but a biosocial hypothesis is proposed with respect not only to broad factors such as biological changes and social influences, but to mediating factors. Specifically, the influence of three such sources on social behavior is tested—namely, biological factors, perception of self (in particular self-perceived maturity), and interpersonal relationships (in particular through peer relations). Besides focusing on individual differences, the interest being on different outcomes for different subgroups of subjects, the essay also demonstrates convincingly the need for long-term longitudinal studies. Indeed, this chapter as well as Magnusson's work in general (see also Magnusson, 1988) shows that only long-term studies can help avoid overgeneralizations and errors in prediction. If early onset of puberty, as mediated through self-perceived maturity and peer relations, does indeed seem to induce early drinking habits, the relationship does not hold later on; the late maturing girls caught up, so that at adult age no difference was found between early matures and late matures in terms of alcohol consumption. Adopting a long-term longitudinal design helps demonstrate that it is only within a limited period of time that early matures can in some respect be considered socially deviant.

Harris is interested in the development of self-knowledge with respect to one's own emotional experience, specifically in the developmental decalage (what Piaget would probably call a vertical decalage) between the behavioral manifestation of emotion and its acknowledgment by the child in two domains, ambivalence and display. Developmental end states are thus behavioral expression of emotion (for instance, ambivalence as early as 1 year of age, or the possibility of masking emotions or disappointment by 4 years of age) versus verbal acknowledgment of the same emotions, which appear only much later. In the two domains, the developmental sequence is described as consisting of three levels: denial of the co-occurrence of two emotions, acknowledgment that two conflicting emotions can coexist but only successively or when reasons for hiding emotion are made explicit by the experimenter, and finally acknowledgment that the same situation can elicit two conflicting emotions (or that the same person can display one type of emotion while feeling another way). Incidentally, such a sequence can be compared with Siegler's sequence of Rules (e.g., Siegler, 1986) or to the system of dimensions of transformation proposed by the research group to whom the present author belongs (e.g., de Ribaupierre & Rieben, 1985; Rieben, de Ribaupierre, & Lautrey, 1983; 1986).

In Piagetian terms, the mechanism of transition responsible for the development of acknowledgment (and therefore for the vertical decalage) would probably have been that of reflexive abstraction (e.g., Piaget, 1950; 1977), allowing for a reconstruction of the behavioral system on a representational level. In contrast, Harris suggests that the decalage is due to the existence of two different modes of appraisal, "a rapidly developing and relatively exhaustive mode of appraisal that immediately translates itself into emotional behavior, and a more slowly developing system of conscious appraisal." In turn, this asks the question as to why there are two different modes and why an exhaustive search is not possible earlier. The factor responsible for the development of the second system is, according to Harris, socially marked and consists in an amplification by the environment of the child's variations in behavior.
That environment plays a role in forcing the child to carry out a more exhaustive search looks indeed like a promising hypothesis, but this hardly seems to constitute a sufficient reason or a psychological mechanism. Harris discusses individual differences in terms of speed differences, and across-task stability; longitudinal studies would then prove necessary to test whether differences of speed in development are stable. A second objective of longitudinal studies is to test the relationship between early behavior and late behavior—for instance, would securely attached children demonstrate earlier consciousness of ambivalence?

Attiti’s chapter represents a further elaboration of the development of the expression of ambivalence in children, by reviewing different research traditions, those of attachment theorists, of psychoanalytic theorists, and of cognitive developmentalists. In contrast with Harris’s position, Attiti argues that display of ambivalence relies on the same system as understanding of ambivalence, and that both develop slowly and through different stages, their main difference being that one is unconscious and the other conscious. The transition principles would consist in the construction of different internal working models and of their progressive integration. Cognitive capacities are considered to constrain the possibility to integrate constraining information. As a consequence, although Attiti does not explicitly say so, increase in cognitive capacities might represent the main mechanism of transition explaining the development of both expression and acknowledgment of ambivalence. Individual differences are dealt with in terms of vulnerability to conditions that lead to pathological development, whereas longitudinal studies are considered necessary to understand when attachment patterns change and what are the factors of change.

The objective of Hofsten’s chapter is to discuss some of the problems and transitions encountered during sensorimotor development and illustrate them through research in the domain of manual development during infancy and early childhood. Developmental products are defined in terms of perception-action systems, which are analyzed from the viewpoint of the changes occurring from early coordinations already present at birth to later similar coordinations (which may be smoother, more accurate, or faster); developmental functions are also shown to undergo regressions frequently. Transition principles seemingly correspond to the well-known principles of differentiation and integration, which are considered to explain the apparent regressions in development. These principles are illustrated in particular with respect to the number of differentiations in the development of reaching and of visuo-proprioceptive systems; four factors are supposed to contribute to the development of successful reaching: breaking up of the extension synergy (i.e., differentiation of the grasping and approaching systems), sensitivity to binocular disparity, uncoupling of head and arm movements, and development of postural stability of the upper trunk. More global transition mechanisms, such as the role of maturation and environment, are also discussed; with respect to the former aspect, biomechanical constraints are invoked and, although important, are not considered to be sufficient to account for development. A number of longitudinal studies conducted by Hofsten are mentioned, but seem to have been used mainly to analyze group results. Nevertheless, Hofsten discusses the importance of individual differences, seen mainly as differences of speed, and illustrates with an interesting example the relevance of longitudinal design for unravelling developmental function and rate of development. This is particularly important when U-shaped developmental functions are found: In the case of the study mentioned, reaching frequency was found to decrease and then increase after 2 months of age. When individuals develop at different rates, averaging data over the group (as is usually the case with cross-sectional data) may possibly mask this U-shaped function completely; through the longitudinal data, Hofsten could show that a decrease followed by a dramatic increase occurred in all individuals.

Bloch’s paper examines the status of early sensorimotor coordinations such as eye-head coordinations and eye-hand coordinations, asking whether they constitute precursors of later behaviors; thus developmental end states are early coordinations versus late coordinations. Several types of changes are suggested: stability (e.g., eye-hand coordinations), increasing accuracy, and regressions. An interesting transition factor that is hypothesized is that of different maturational levels of the different components; that is, the more mature component (for instance, vision in eye-hand coordination) would drive development of the less mature one. Broad transition mechanisms such as biomechanical constraints (considered insufficient as illustrated in her own studies of walking), postural development because it contributes to the elaboration of spatial refers, maturation, and experience are also discussed. Bloch stresses the importance of longitudinal research for studies dealing with the form of development and with the issue of continuity-discontinuity, while seeing its role essentially as one of hypothesis testing.

Finally Butterworth’s paper represents another attempt at describing developmental transitions in early infancy. The neonatal period itself is defined as a period of transition leading from adaptation to intrauterine environment toward adaptation to extrauterine environment; the developmental end states that are being considered are prenatal coordinations versus neonatal coordinations. With respect to transition prin-
principles and transition mechanisms, which are not clearly distinguished, Butterworth proposes a combination of Changeux's and Precht's models, illustrated by the development of neonatal stepping, of hand–mouth coordinations, and of imitation. Specifically, the transition principles proposed are stabilization, labilization, regression, disappearance, replacement by substitution (without developmental continuity) or replacement by integration (progressive embedding of innate systems in higher-order control processes), inhibition by higher centers, connection of different motor systems, and separation of neural components. The respective role of biomechanical constraints as they interact with innate pattern generators and of cognitive changes, in that they allow an instrumentation of the motor systems, is also discussed. Longitudinal studies are essentially seen as dealing with the issue of developmental continuity.

**Wanted: developmental longitudinal studies**

Although longitudinal research is seemingly the most obvious if not the only method for studying developmental changes (e.g., Hoppe-Graff, this volume; Wohlwill, 1973), it is amazingly scarce in developmental research at large; this is somewhat paradoxical given the number of developmental models that have been proposed (indicative of the diverse types of developmental changes that should have been tested). The present book is no exception, even though the authors make a laudable effort to stress the relevance of a longitudinal approach. Given that the objective was to focus on a longitudinal perspective, this book can be taken as a yardstick against which the difficulty of working with longitudinal perspectives can be measured.

Difficulties of longitudinal studies are indeed large; a number of them are discussed at length in an interesting review by Schneider (in press). Three classes of problems are defined: practical problems such as cost factors, recruitment of staff, data storage and funding; conceptual problems linked with the issues of continuity–discontinuity versus stability–instability, the former dealing with the development of a function while the latter is concerned with individual differences; and methodological problems such as appropriate measures of change, models of data treatment, reliability of scores. Hoppe-Graff (this volume) adds the problem of conceptual vagueness, referring to the fact that none of the authors that he mentions can provide an a priori precise prediction of a developmental sequence. This is probably combined with a lack of focus on methods (and underdevelopment of appropriate methods) in developmental psychology, while longitudinal studies inevitably raise complex methodological problems.

I would like to add yet another reason for this scarcity of longitudinal studies; it has to do with the lack of interest on the part of most developmentalists for individual differences. Baltes and Nesselroade's rationales for longitudinal research (Baltes & Nesselroade, 1979; Hoppe-Graff, this volume) all deal with identification of individual changes, whether intraindividual or interindividual changes and whether for a descriptive or explanatory purpose. In contrast, most developmental models have been concerned with discovering universal laws, applying them either to a general theoretical subject such as Piaget's epistemic subject or to age groups data. In so doing, most models have remained fundamentally unidimensional and have confounded developmental changes with developmental differences (e.g., Schneider, in press; Wohlwill, 1973). In this case, longitudinal studies in their model-testing aspect still prove necessary to test the transitions that are hypothesized; however, the fact that they are then seen as restricted to testing the continuity–discontinuity aspect of the developmental function might not represent a strong enough incentive for overcoming all of the difficulties mentioned earlier. Further, when relying on a unidimensional model of development, results of cross-sectional studies might do the job almost as well (provided the samples examined are close enough in age) and much more easily. Inferences from the group data are then transferred to individuals – that is, age differences are translated into developmental changes.

The last statements may seem to contradict somewhat the remark at the beginning of this chapter that developmentalists had started acknowledging individual differences. However, in most cases, although considered important, individual differences are most often construed as mere differences of speed or rate of development at a surface level (e.g., Dasen & de Ribaupierre, 1987); a longitudinal study would then only serve to demonstrate that such differences of rhythm are stable, which may not prove fundamental for a test of the model under question. Only when development is considered as multi- or pluridetermined (e.g., Pascual-Leone, 1983; de Ribaupierre, in press; de Ribaupierre, Neirynck, & Spira, 1988; de Ribaupierre, Rieben, & Lautrey, 1988; Rieben et al., 1986), both by general developmental and by differential mechanisms, does it become really important to study developmental forms and their stability. Individual differences then play a fundamental and probably qualitative role in terms of processes, and it becomes crucial to test whether their influence is stable. For instance, Longeot (1978) modified
the Piagetian model by assuming the existence of developmental loops, followed by different types of subjects, leading from one developmental end state to the next; if one assumes two types of loop (A and B) at two different stages, it becomes fundamental to test not only the continuity of one type of loop (i.e., to determine whether Loop A at Stage 2 is a direct continuation of Loop A at Stage 1), but also the individual stability (i.e., whether subjects following Loop A at Stage 1 will also follow Loop A at Stage 2). Similarly, Rieben et al. (1986; 1988) have recently argued that, at a given developmental level, there are at least two different modes of processing applicable to Piagetian situations, namely a digital and an analogical mode; such modes are not only assumed to be differently elicited by situations, but also to correspond to individual differences. It is then essential to conduct longitudinal studies to test whether there is a continuity between the digital mode inferred during an age period and the digital mode at age and, still more important, whether subjects qualified as preferring a digital mode at a given age still present this preference later on (de Ribaupierre et al., submitted). A final example can be taken in the field of memory. As well analyzed in Schneider and Weinert’s chapter, memory development is presently conceptualized as depending on at least four sources. The relative contribution of each source may differ during different periods of development (e.g., Siegler, 1986); it may also differ across individuals of a given level. Provided each source could be empirically singled out (de Ribaupierre et al., submitted; Schneider & Weinert, this volume), it would again prove crucial to conduct longitudinal studies to test the relative impact of each source at different moments, and the stability of its influence for a given individual.

A further argument in favor of the thesis according to which longitudinal studies have been little used in developmental psychology because of the lack of interest for individual differences comes from the fields of personality and psychopathology: In these areas, researchers have been primarily concerned with interindividual or intergroup differences, whether for purposes of prevention or for explaining deviant behavioral outcomes, and longitudinal studies are flourishing. Incidentally, it has to be remarked that very often these studies have neglected the study of changes within individuals (e.g., Rutter, in press). Longitudinal studies certainly are no panacea, and have limits that have not been analyzed here; nevertheless, let us hope that, in the near future, more developmentalists will be convinced of the existence of different developmental paths for different types of subjects and will be ready to overcome practical and methodological difficulties, which, although heavy, are not insurmountable. To limit the costs, however, longitudinal studies should preferably be restricted to their model-testing aspect—that is, used to test hypotheses about developmental transitions that have been derived from cross-sectional studies.

REFERENCES


