

1 Studying individual development: problems and methods

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INTRODUCTION

The ultimate goal for developmental research is to understand and explain the developmental process underlying an individual's way of thinking, feeling, acting and reacting at a certain stage of the life process.

In order for empirical research to contribute effectively to this goal there are three crucial aspects of the research strategy which are important:

1. the problem under consideration,
2. the data used to reflect the structures and processes involved, and
3. the methods applied for data treatment.

An important prerequisite for the formulation of relevant problems is a careful analysis of the phenomena, in this case the functioning of the individual at the appropriate level of the structures and processes relevant for the problem. Too often problems are formulated with reference to theories which have not been anchored in careful observation and analysis of the phenomena, a circumstance which has contributed to much artificial theorizing and meaningless empirical research.

The crucial importance of using data relevant to the character of the problem, with respect to reliability, validity, level of generalization, etc., was comprehensively dealt with in an earlier volume in this series (Magnusson & Bergman, 1990).

The focus of this volume is on methods for data treatment. The emphasis is on the importance of careful linking of methods for data treatment to the character of the substantive problem under consideration in the specific case. The choice of method for data treatment should always be made with reference to an analysis of the structures and processes relevant to the problem under consideration. Too often the choice of method is made on the basis of its technical sophistication.

During the last decades a series of technically sophisticated methods for data treatment have been developed (LISREL, path analysis,

log linear analysis, etc.). It has become a fashion to use such methods, sometimes without investigating if the assumptions made by the methods are really met. The value system sometimes seems to reward technical sophistication in data treatment independent of its effectiveness in answering substantive questions. It is self-evident that no sophisticated method for data analysis can save bad data or contribute to better knowledge of the developmental process if it does not match relevant problems anchored in the world of real phenomena.

Each correct use of a method for data treatment is dependent on a set of specific conditions or assumptions, which must be met. Such assumptions pertain to the phenomena under study, to the theoretical concepts used and to the properties of the data. To the extent that these assumptions are not met, the empirical results will give false answers to the questions. The important fact that the method for data treatment applied in the specific case can determine the outcome, is cogently illustrated by Brown, Harris and Lemyre in Chapter 4.

THE CHARACTER OF THE DEVELOPMENT PROCESS

An individual functions currently and develops as a totality in which each specific aspect gets its functional meaning from its role in the totality. Developmental research is concerned with which psychological and biological factors in the individual and which factors in the distal and proximal environment are involved and operating in the developmental process. An essential feature of the process is that these factors are in constant, reciprocal interaction.

All aspects of the total functioning of an individual cannot be successfully investigated in one or a few studies. In each specific case it is necessary to break down the totality into substructures and sub-processes which form the frame of reference for the formulation and elucidation of the problem under consideration. In this breakdown of the total process it is essential for the interpretation of empirical results that the subspace under consideration is defined with consideration to the functioning of related subspaces and to the functioning of the totality.

Over time the process in which an individual is involved and develops has the characteristic features of a multidetermined, stochastic process, i.e., there are many factors operating and we deal with probabilities (Magnusson, 1988). In this process many factors contribute to the existence of individual differences in functioning at a certain chronological age. Two circumstances are of particular interest.

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1. The multidetermined, stochastic character of the process itself contributes to individual differences. For example, significant events (Magnusson & Törestad, in press) and independent factors in the environment may have as a consequence 'turning points' as discussed by Pickles and Rutter in Chapter 7.

For our understanding of their role in individual functioning and in interindividual differences, it is important to observe that such events occur at different ages for different individuals. This fact may lead to different impacts in different individuals, owing to differences in preparedness and the role it plays in the total functioning of the individual.

For the central topic of this volume, namely the importance of choosing methods for data treatment with reference to the character of the phenomena, the multidetermined, stochastic feature of the developmental process has a crucial implication: when certain aspects of individual functioning are regarded and treated as nomothetic variables in statistical analysis, the relations among variables across individuals most often are nonlinear (cf. Hinde & Dennis, 1986; see Chapter 15 of this volume, by Bergman and Magnusson).

2. The second important factor contributing to individual differences in individual functioning in a certain situation at a certain chronological age is the existence of sometimes large individual differences in growth rate (Magnusson, 1985). Such differences occur not only for biological but also for cognitive–emotional aspects, such as language development, intelligence, etc. Certain deviances from the normal rate of development indicate a lower final stage of functioning while others are only indications of a delayed development with a later catch up.

What has briefly been summarized above has essential consequences in developmental research for the choice of methods for data treatment in each specific case, and for research strategy. It affects the choice between categorical and continuous data and between variable-oriented methods and profile-oriented methods in treatment of data. These consequences will be discussed later in this chapter.

Here one important implication for developmental research should be emphasized, namely the necessity of conducting longitudinal research, i.e., following the same individuals across time. The inappropriateness of a cross-sectional approach for the study of development as a stochastic, multidetermined process, with the implications briefly summarized above, should be obvious. Longitudinal research is demanding: it not only needs consistent funding over long periods of time; it also requires more careful planning than cross-sectional studies, theoretically, organizationally, and administratively. Following the same individuals over time, wherever they have moved, is demanding, and the

personal involvement and engagement over time, along with long periods of waiting for the results and possible rewards, make longitudinal research less attractive. Cross-sectional studies most often yield data which contain enough linear variance to show statistical significance. However, if we really want to understand and explain individual development as a process, there is no alternative to longitudinal research.

STABILITY AND CHANGE IN THE DEVELOPMENTAL PROCESS

During the last decades a central issue for debate, both in personality and in developmental research, has been the issue of *personality consistency*. In developmental research consistency has often been discussed in terms of stability and change. One cause of confusion in the debate about personality consistency has been the lack of clear conceptualization. It is possible to distinguish four basic meanings of the concept.

1. *Absolute stability*. According to this definition, an individual is assumed to function with respect to a certain aspect in the same way in an absolute sense across different situations and across time. No one argues seriously that this would be the case for specific manifest behaviors. However, it seems to be implied at the trait level to some extent in some extreme trait theorizing.

2. *Relative stability*. This is a statistical definition of cross-situational and temporal personality consistency. According to it, an individual is stable with respect to a certain aspect of individual functioning if he/she retains – across situations and across time – his/her position in the rank order of individuals in the sample to which he/she belongs. This meaning of developmental stability for a certain aspect of individual functioning is usually expressed in a coefficient for the stability of rank orders obtained at two different points in time.

Formulations of the interpretation of high stability coefficients sometimes imply that they mean high temporal consistency in the absolute sense, as discussed under point 1. However, it must be kept in mind that correlation coefficients expressing relative stability for a certain aspect of individual functioning do not say anything about stability in terms of the absolute level of functioning.

A survey of the literature on temporal stability shows that the overwhelming number of empirical studies on which the discussion of stability and change in development is based report figures for relative stability, i.e., for personality consistency in statistical, relative terms.

Of course, correlation coefficients expressing the stability of rank orders for a sample of individuals for a certain aspect of individual

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functioning reflect the extent to which the individuals retain their rank orders from time to time. However, it should be kept in mind that when time refers to chronological age, stability coefficients may be unduly deflated by two factors:

(a) data for the variable under study may not express 'the same' latent variable at time 1 and time 2, even if they superficially have the same character as indicated by being based on data from the same instrument, and

(b) individual growth curves, though having exactly the same shape, may have different onsets and peaks for different individuals (cf. Magnusson, 1985).

Both absolute and relative stability are definitions of personality consistency in statistical terms.

For discussing personality consistency in a cross-situational and in a temporal perspective, respectively, the terms *coherence* and *lawful continuity* have been introduced (cf. Magnusson & Törestad, in press).

3. *Coherence*. Across situations each individual's way of functioning in all respects is characterized by coherence, i.e., it is coherent and explainable, without necessarily being stable in either absolute or relative terms for each aspect. The basis for the assumption of coherent patterning of manifest behaviors across situations is the coherent way in which an individual interprets the information that the environment offers in each specific occasion/situation, and how he/she uses this information as a basis for inner and outer activity.

4. *Lawful continuity*. According to the definition of personality consistency in terms of lawful continuity, individual development is lawful and consistent in the sense that the total functioning of an individual at a certain stage of development and any change in this respect takes place against the background of, and is lawfully connected with, the individual's earlier history of maturation and experience. Any change in the individual's way of functioning is a lawful consequence of the state of the organism, psychologically and biologically, and its way of dealing with external events and their consequences. This view on stability and change in individual development has implications for the choice of data for the elucidation of a certain problem and for the choice of methods for data treatment in longitudinal research (see Bergman and Magnusson, Chapter 15 of this volume).

PROSPECTIVE AND RETROSPECTIVE APPROACHES TO LONGITUDINAL RESEARCH

An important distinction with respect to longitudinal research strategy is the one between a prospective and a retrospective type of analysis. An example may be helpful to clarify the distinction. Let us assume that the

problem under consideration is a hypothesis concerning the developmental background to adult criminality. A *prospective* analysis of this problem takes its starting point in data referring to an early age, say ten years of age, for factors that are assumed to be of relevance, e.g., aggressiveness, hyperactivity, intelligence, and social background. The answer to the question if and to what extent these factors are operating in the developmental process leading to adult criminality will then be sought in data for adult criminality. A *retrospective* analysis of the same problem takes its starting point in data for adult criminality and investigates the hypothesis about the relevance of the given set of variables in the development process by comparing those who have committed crimes at adult age and those who have not, using data from the early age for the hypothesized variables.

A prospective approach means looking forward to the outcome of the process, a retrospective approach means looking backwards to the antecedents. When the two approaches have been discussed and evaluated, the general conclusion has been that a prospective approach is more effective than a retrospective. This conclusion is often based on the deficiencies in retrospective *data* which have been elucidated in empirical research (cf. Janson, 1990). However, this means a confounding of two issues, namely the research strategy and the type of data.

Four aspects of data used in longitudinal analyses should be distinguished (Janson, 1981, 1990; Magnusson, 1988).

1. *The reference point in time.* The particular occasion or age level in a person's life that a datum refers to.
2. *The coding point in time.* The point in time when the observation is coded into a datum. For example, the observations that a teacher makes about a pupil can be expressed in a datum in direct connection with the observation or ten years later.
3. *The collection point in time.* The point in time when the researcher collects the datum. For example, a register datum for a certain individual may refer to a specific age level and has been coded at the same time that it refers to but is collected by the researcher much later.
4. *The usage point in time.* The point in time when the researcher uses the data for calculation.

A common mistake is that it is the collection point in time that determines whether data are prospective or retrospective: if data are collected at the end of the process, they are regarded as retrospective data, if they are collected during the process they are regarded as prospective. However, the collection point in time is of no relevance for the distinction between prospective and retrospective data. What is decisive is the relation between the *reference point* in time and the

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coding point in time. If the reference point in time and the coding point in time coincide a datum is not retrospective, independent of the points in time for the collection and usage. If they do not coincide, the datum is retrospective. In principle, both a retrospective and a prospective analysis can use both prospective and retrospective data.

Thus, the problems concerning a prospective and a retrospective approach to longitudinal studies and concerning prospective and retrospective data in these analyses are two different problems. That retrospective data often have lower quality than prospective data does not invalidate the retrospective research strategy per se. Prospective and retrospective analyses of developmental problems elucidate the same kind of problems by studying such problems in different ways. In principle both of them can use both prospective and retrospective data as in the example given above. What is decisive for the choice between a prospective and a retrospective analysis in any specific case is the problem under consideration, the character of the sample for which data are available, and the properties of the data. Indeed, in situations with an outcome variable that is rare, for example, when the object of interest is an illness with a low frequency of occurrence, the only feasible approach may be a *case-control study* in which a sample with the rare condition and a control group are studied retrospectively.

PROBLEMS IN STUDYING STABILITY AND CHANGE

Do both quantity and quality change with time?

As briefly mentioned earlier, studying change or growth in a single variable when the variable measured is not really ‘the same’ at the different ages poses difficulties. Even if the same operationalized measure is used at different points in time, the measures may not be indicators of the same theoretical concept. For instance, a test consisting of simple mathematical problems may primarily measure inductive–deductive ability at the age of ten but numerical ability at age 15. (The problem of changing meaning of measures with age is discussed by, for instance, Wohlwill, 1973.) This situation may create all kinds of interpretation and analytic problems as discussed in Bergman (1972) and Harris (1963).

The above-stated implications for the study of individual development are, of course, different depending on the character of the variables under investigation. When studying how one aspect of behavior evolves into another aspect of behavior at a later age (heterotypic continuity), the problems to handle are different from studying an aspect of behavior

which maintains its character over time (homotypic continuity). It is of foremost importance that the researcher is explicit about what theoretical concepts the studied variables measure and to what extent the operationalized measures change their meaning with age.

It often appears to be sound advice that one should avoid measures of change when studying individual development and instead consider ‘the same variable’, measured at different points in time as different but related variables. This advice has implications both for the choice of measurement procedures and the choice of statistical methods (Cronbach & Furby, 1970).

The situation is different if the aim is not to study ‘the same thing’ at different ages. In certain approaches the attempt is not to measure the same variables at the different ages but rather to measure indicators of relevant (and partly different) concepts at the different ages (cf. Magnusson, 1988, and Bergman & Magnusson, Chapter 15 of this volume).

Matching concepts and measurement models

The above argument also highlights the importance of using appropriate measures that really reflect the concepts one wants to study. Again and again it has been pointed out that an explicit measurement model is needed in which the theoretical concepts are linked to the observed variables (Magnusson, 1988; Rudinger & Wood, 1990; Rutter & Pickles, 1990).

The type of scale appropriate for the measurement model is, of course, entirely dependent on the problem area. For instance, it is a misunderstanding that a continuous scale, whenever it is obtainable, is always preferable to a discrete or categorical scale. Some phenomena are naturally discrete or categorical and are distorted if they are described by a continuous variable. This is exemplified by Brown *et al.* in Chapter 4.

Making causal inferences

Ethical and practical problems usually prohibit the use of powerful random control experiments when studying individual development of human beings, forcing the researcher to use non-experimental data. The difficulties involved in making causal inferences using such data are well known (see, e.g., Cook & Campbell, 1979). It is also well known that the situation in this regard can be more favorable in a longitudinal context than in a cross-sectional context since the time-ordering of the variables in the former context gives information that can be used when building causal models. This use of time-ordering is exemplified in

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several chapters in this volume, for example by Pickles and Rutter in Chapter 7, concerning the effects on adult adjustment of childhood factors, by Rudinger, Andres and Rietz in Chapter 13, concerning the growth of intelligence, and by Molenaar, Boomsma and Dolan in Chapter 12, concerning the operation of genetic factors at different ages.

Confirmation versus exploration

It has often been stated that a confirmatory approach is preferable to an exploratory one. In a confirmatory approach a specific theory is tested by examining whether or not the observed data are consistent with those that are predicted from a statistical model generated by the theory. In an extreme form this means that the theory and statistical model are formulated beforehand and the data set is only used for the binary decision of retaining or rejecting the theory. This approach has been contrasted to another extreme; an exploratory approach in which the researcher performs various analyses on data and explores within a more vague theoretical framework, using the findings for hypothesis generation which can be tested empirically on another set of data. The dangers in this second approach are obvious.

However, within the context of studying individual development, the limitations of a confirmatory approach should be recognized.

First, it should be noted that a high-quality longitudinal data base is very difficult to obtain. It requires a great deal of time, money, and effort, especially if the study covers a long time period. Such a data base is simply too valuable to be used for a theoretical one-shot (cf. Bergman, 1988).

Second, in many areas of individual development the issues are very complex and no thoroughly sound body of theory exists. This means that theories that can be made before looking at the data are bound to be over-simplified and the rejection of such a theory does not provide much information.

Third, using a confirmatory approach may increase the danger of confirmation bias (Greenwald *et al.*, 1986) by which is meant that the procedures, testing and reporting are too much geared towards fitting into the existing theoretical framework.

Of course we do not advocate an atheoretical explorative approach of merely stocking facts; exploration should be aided by a theoretical framework and should result in new theoretical formulations (Bergman, 1988; Magnusson, 1990). In this connection the need for replication and cross-validation should be stressed, as has been done by others (Rutter & Pickles, 1990).

Somewhere along the line, the common-sense aspect of knowing the facts before theorizing has been lost in many cases. The consequences of

this loss are more expensive in the longitudinal field than in most other fields, and research about individual development would, in our opinion, do well by emphasizing careful observation, description and micro-theorizing and dwell less on more formal confirmatory approaches.

SOME VARIABLE-ORIENTED METHODS: ASSUMPTIONS AND APPLICATIONS

The variable-oriented approach

In this section the assumptions and applications of some variable-oriented methods will be discussed. By 'variable-oriented methods' we mean those methods in which the main conceptual and analytical unit is the variable. For instance, the focus of interest is on mean differences for a certain variable or on the relationships among variables (latent or manifest). Several such approaches are illustrated in this volume addressing various problems in studying individual development. The uses of modern, powerful analytical tools are illustrated within different areas such as the study of the development of intelligence by Rudinger, Andres and Rietz, in Chapter 13 (structural equation modeling using LISREL), gene-environment contributions to phenotypic variance in a developmental perspective by Molenaar, Boomsma and Dolan in Chapter 12 and Pedersen in Chapter 11 (time-series analysis using LISREL). Blossfeld, Hamerle and Mayer in Chapter 10 illustrate the use of event history analysis for studying social mobility. In other chapters, means or variances of key variables are compared between groups of subjects over time (this is done by Olweus and Alsaker in Chapter 6 using a cohort-longitudinal approach with hierarchical data and by Nesselroade and Featherman in Chapter 3 focusing on intraindividual variability in depression scores).

In these chapters, some attention is given to the assumptions and conditions necessary for the adequate use of the methods. This is a complex issue, dependent on both the nature of the phenomena to be studied and on the specific methods to be used. In the following, the issue is discussed in some detail for some rather simple situations. In this way the reader is given examples of some ways of thinking about assumptions and conditions for applying a statistical method that, it is our hope, provide a base for understanding these issues in more complex situations.

Assumptions and applications in some simple cases

In an ordinary longitudinal study, subject matter knowledge and theory give a basis for a model. With access to appropriate data a statistical