Structural invariants and individual differences: On the difficulty of dissociating developmental and differential processes

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Structural Invariants and Individual Differences: 
On the Difficulty of Dissociating Developmental 
and Differential Processes

Anik de Ribaupierre

In keeping with the theme of this volume, I address two questions: 
(a) is a structuralist approach compatible with a focus on individual differences, and (b) what is a constructivist approach to the problem of individual differences? I first discuss what is implied by the term structure and what is entailed by a structuralist method in developmental psychology (more particularly within the Piagetian tradition). I then address the relationship between structure and developmental synchronism. My argument will be that it is necessary to define structural invariants before analyzing individual differences, because most performances are multidetermined by both developmental and differential processes. Finally, I attempt to illustrate, through two research programs, the proposed combination of developmental and differential perspectives.

Is a Structuralist Approach Compatible with a Focus on 
Individual Differences?

According to the view adopted throughout this chapter, a structuralist approach is not only compatible, but imperative for a study of individual differences [de Ribaupierre & Rieber, 1985; Rieber et al., 1986]. A minimal definition of structuralism is a method for detecting invariances across subjects and/or situations, as well as a theory asserting that such invariances exist. It is a prerequisite (although certainly not sufficient) for any meaningful comparison of behaviors across situations and for disentangling the developmental aspects of these behaviors from the differential ones. It can of course be further elaborated by formalizing the structures, as in Piagetian theory, but this step is not imperative.

Psychometricians in the factor-analytical tradition looked for structures. They asked whether a group or subgroup of subjects behaves similarly across situations. Thus, they were looking for nonobservable entities underlying observable performances. In so doing they defined structural invariants in terms of factors. The error of theoreticians like Guilford was not the search for structural invariances, but rather the assumption that structural invariants such as factors, which are defined on the basis of task descriptions, can provide a straightforward account of internal processes and representations [de Ribaupierre and Pascual-Leone, 1984].

In developmental psychology, structuralism has most frequently been associated with the Piagetian approach. In this tradition, the term has been taken in a much stricter sense and has been identified with the notion of universals. Piaget used the concept of structure to account for the formal properties of thinking, both horizontally (thinking in different situations and/or domains that exhibit identical properties) and vertically (thinking at different ages presenting different formal properties). He defined a structure as a system of transformations. A structure obeys laws as a system (in contrast to the properties of its elements) and is conserved or enriched by the very interplay of its transformations, i.e., autoregulations [Piaget, 1968]. Piaget formalized such structures through the use of mathematical models. He believed that structures so formalized could be considered as universals, in the sense of operating in all situations as well as in all subjects of a given developmental level.

The term structure d’ensemble (overall structure) refers to this formalization of a whole range of behaviors, universal in the sense that it can be observed in all situations and in all subjects. This concept, however, was also interpreted by Piaget’s readers as meaning that the structure was operating all at once (i.e., as a single functional unity), although Piaget himself never explicitly asserted this. It was thus often concluded that, because all behaviors of a characteristic period of thinking could be described by the same structure, they had to be synchronous. As a result, one of the most frequent criticisms of Piaget’s theory of stages is that it is contradicted by empirical data on the lack of synchronism across tasks presumed to reflect the same stage.

The conclusion that the concept of structure d’ensemble implies developmental synchrony across content areas is based on a confusion between formal properties and functioning totalities [Chapman, 1988]. The fact
that Piaget recognized the same formal structure in different areas of content does not imply that these areas are united in a single functioning totality. In fact, Piaget never explicitly stated that behaviors should emerge synchronously. On the contrary, he stressed on several occasions that synchronism was not to be expected:

There are no general stages [referring here not only to cognitive, but also to organic, affective and social aspects of development]. Just as in connection with physical growth, Tanner showed us that there was an absence of close relationships between the skeletal age, the dental age, etc., similarly in the various neurological, mental and social fields, we see an intermingling of processes of development which are evidently interrelated, but to different extents or according to multiple temporal rhythms, there being no reason why these processes should constitute a unique structural whole at each level [Piaget, in Tanner & Inhelder, 1956, p. 14].

This behavior of 'swinging' already belongs to the fourth stage with respect to the general development of intelligence. But, with regard to object concept, the deferred reaction to which it gives rise in this observation does not yet transcend the level of the third stage. It is apparent that, without considerable artifice, it is impossible to synchronize the corresponding steps of the evolutions peculiar to the various categories of sensorimotor intelligence, and that temporal displacements [décalages] are produced, the more comprehensible the farther removed they are from the elementary stages [Piaget, 1955, p. 28; italics added].

I could not find, at least in a rapid search, a passage in Piaget's work that directly indicates that synchronism is to be expected. However, I think that Piaget's writings were misleading enough to have induced this confusion. First, he systematically referred to the fact that behaviors reflect a structural unity across domains. Again, this does not imply that they should function as a unity or, in other words, that synchronism is the rule, although it can and has been so understood. Second, the very fact that the term 'décalage' was introduced implies that asynchronism is in need of some special explanation. Third, the role assigned to age was particularly ambiguous. On the one hand, Piaget stated that age was not important; on the other hand, he relied on similar average ages in the attainment of a concept to validate the hypothesis that development is isomorphic across different domains.

Thus, even though asynchronisms do not contradict Piaget's theory, they clearly point to its insufficiency and to its lack of predictive power as a psychological theory. In particular, horizontal decalages can only be explained a posteriori (when they can be explained at all), but never predicted. Hence, we need theories of the subject that are more psychological than epistemological.

Because of the confusion between the universality of structures and their presumed need to function as a single entity, numerous researchers beginning in the 1960s insisted on the domain specificity of development. A strong emphasis on process and on contextualist approaches emerged, while the problem of individual differences was overlooked. Research concentrated on specific task factors, learning, and cultural backgrounds. However, such models, asserting the domain specificity of development, soon encountered problems. Whereas the Piagetian model was unable to account for heterogeneity, the revisionist models could not account for important regularities that were observed. As a result, a strong interest in structuralist approaches to development has re-emerged, exemplified in the neo-Piagetian movement [Case, 1985; Edelstein et al., 1990; Fischer, 1980; Halford, 1987; Pascual-Leone, 1980, 1987; Schröder and Edelstein, 1991]. These neo-structuralist perspectives do not represent a complete return to Piagetian structuralism. The structures defined are often more local. They correspond to finer distinctions within a developmental period and grant a larger role to the contextual aspect of cognition. Structural invariants are of a quantitative and/or qualitative type and the relationships among the elements of the structure are either syntactic (formal) or semantic, as in Case's proposal of the existence of central conceptual structures [Case and Griffin, 1990; see also this volume].

A final point with respect to the concept of structure is that it is descriptive. Structural invariants, even ones as general as those underlying the general stages postulated by Piaget, remain constructs that describe a set of task accomplishments. They reflect intrinsic constraints on development and constitute a taxonomy insofar as they represent a range of performances possible at a given level of development, as well as a developmental sequence across domains. They may sometimes be assumed to correspond to psychological realities (that is, to schemes that really function within subjects) or they may be taken as observer's descriptions. The morphological similarity across situations they are supposed to reflect may be caused by underlying processes that impose constraints on the representations that can be built. For instance, an underlying process constraint in most neo-Piagetian models is a limited information-processing capacity. Still, structural similarity does not imply that development is completely synchronous; temporal decalage is still possible, due to the greater or lesser ease of functioning of a given structure in different situations and for different individuals.

I claimed earlier that a structuralist approach is necessary for studying individual differences. Indeed, I will argue that most performances reflect
both developmental and differential aspects, the term differential referring here to a style or manner rather than to a level of functioning, that is, to different and possibly equivalent types of mechanisms that may be at work at the same level of development, as opposed to greater or lesser efficiency of the same mechanism. Because of a frequent confounding between manner and level of functioning, mere comparison of scores of different groups or individuals on the same task does not permit us to attribute the differences to developmental or differential factors. The controversy regarding cognitive style versus cognitive level [Globerson and Zelinker, 1989] reflects this confounding. The obverse is also true. When comparing scores across tasks and observing intra-individual heterogeneity, we do not know whether the differences (or the lack of correlations) originate in a greater complexity of some of the items or in the fact that the items call for different mechanisms.

Thus, there are at least two reasons why we must define structural invariants across tasks before examining individual differences. One is to provide a means of establishing correspondences between tasks or items that may differ from the standpoint of their difficulty. One does not expect the same rate of success on two tasks that differ in complexity. It is therefore necessary to define explicit criteria for equivalent behaviors, i.e., to have a common metric. A second reason is to provide a means of grouping individuals who may be at the same developmental level on a task, although their observable performances are in fact different. This objective is particularly important for behaviors characterized as intermediate on Piagetian tasks. Defining structural invariants makes it possible to determine the various forms that a similar underlying level (i.e., the structural invariant) may take when it is actualized in a given situation (the functioning of a structure may indeed be different for different individuals) and to compare patterns across tasks. In summary, defining structural invariants is not sufficient to understand individual differences, because situational aspects also influence performances. It is, however, a necessary first step.

What Is a Constructivist Approach to Individual Differences?

Individual differences have been dealt with in developmental psychology in a number of ways [Buss, 1979; Wohlwill, 1973], not all of which can be considered constructivist. The most frequent is implicit ignorance or neutralization of individual differences, by studying the average or ‘epistemic’ subject. Individual differences may be acknowledged afterwards, but no real place is assigned to them in the theory. As a consequence, they are viewed as mere variations around a norm, i.e., as simple differences in developmental rate. Piaget himself never denied that subjects can differ in the rate of development, but he was not interested in the question and never treated it systematically [Inhelder and Piaget, 1971].

A second approach has been to focus on inter-individual differences. Samples of subjects have often been constituted on the basis of some independent variable (such as SES) and compared with respect to their level of achievement on a dependent variable, such as a Piagetian task. Alternatively, the correlation between the two variables has been analyzed. As a consequence, the focus is on groups, rather than on individuals, with individual differences considered as quantitative variations. Two types of independent variables have been taken into consideration most frequently. The first are external variables such as social class or gender. Individual differences are here again considered as variations around a norm; for instance, one can ask whether lower-class children are less advanced in their operational development than upper-class children. The model of development thus remains a unidimensional one. The second sort of variable that may produce individual differences is internal (i.e., of a psychological nature). Some investigators have studied what have been labeled ‘performance variables’ or ‘moderators’ [Neimark, 1985], such as ability or cognitive style. Scores on a test of cognitive style or IQ or scholastic achievement serve as predictors of performance on a developmental task. For instance, it could be asked whether field-dependent subjects are slower to reach the concrete operational stage. Again, in this type of study, even though this is not its extrinsic characteristic, individual differences are considered most frequently within a unidimensional frame of reference. Development is the same for all, and subjects differ only in the rate of development.

The objective of a third approach has been to carefully control for individual differences, either through experimental manipulation and/or selection of subjects, so that developmental differences can be studied more clearly. In some sense, this approach is the reciprocal of the preceding one (in which a psychological variable that may cause individual differences is focused). Here, however, the independent variables (source of individual differences) are supposed to be controlled, because they might interfere with the clear emergence of a developmental factor. This was
Pascual-Leone’s (1970, 1978) objective in studying the development of M power in different situations, or Case’s (1983) in elaborating paradigms for studying the growth of short-term storage space. Specific tasks were constructed, minimizing individual variability through a number of experimental controls. For example, obvious and often overlearned simple stimuli were used. Because experimental manipulation of the situation may not be sufficient, Pascual-Leone also controlled directly for individual differences by selecting subjects. For example, only field-independent and normal-IQ subjects were examined. Using such controls, Pascual-Leone obtained in several tasks (particularly the Compound Stimuli Visual Information task illustrated later) numerical values that increased linearly with age, were associated with the Piagetian substages and proved invariant across situations. They were interpreted as measuring the M operator [Goodman, 1979; Johnson et al., 1989; Pascual-Leone, 1987; Pascual-Leone and Goodman, 1979]. Furthermore, they took the form of step functions across age groups, such as those that should be found if there were true general developmental stages. This is a sufficiently rare outcome in the developmental literature to warrant emphasis.

The method of ‘testing the limits’ used by Baltes and collaborators [Baltes, 1987; Kliegl and Baltes, 1987] is another example of this type of approach. By teaching a specific strategy to subjects and ensuring via thorough learning that all subjects reach an asymptotic performance, one may control for individual variation in strategic usage. As a consequence, the differences observed between age groups are more likely to reflect true developmental processes.

The objective of a fourth approach has been to study the extent and/or the form of variability for a given individual across a range of tasks. A possible second step consists of using intra-individual differences to define groups of subjects, i.e., to examine inter-individual differences in intra-individual variability [Buss, 1979]. Subjects are grouped according to the similarity of individual performance patterns across tasks. When not only the magnitude but also the form of intra-individual variability differs, individual differences can no longer be considered as mere variations around a norm within a unidimensional framework. They signify that different developmental paths exist [Lautrey et al., 1985, 1986, 1987]. Longeot (1978) suggested modifying the Piagetian model somewhat, by assuming the possibility of different developmental loops for different subjects at the same stage. Figure 1 contains a theoretical example of two such developmental loops, corresponding to two developmental paths followed by hypothetical subjects – path 1–2–3–4 for subject A and path 3–4–1–2 for subject B, – with the digits representing achievement on a concrete operational task. Because most developmental studies are cross-sectional and not longitudinal, Longeot suggested studying intra-individual variability using an extension of Guttman scale analyses and focusing on patterns of passes on items belonging to the same stage. Table 1 shows that, in a cross-sectional study conducted at the middle of the concrete operational period, the two subjects would present clearly different intra-individual patterns. In Longeot’s model, the developmental loops are characteristic of a preparatory phase and merge at the end of a stage. One can, however, wonder whether such patterns might not also transcend stages.

Adopting a multidimensional perspective leads one to postulate that different sources, either singly or in combination, influence performance. If there were only one source of variation, developmental sequences would indeed be identical for all subjects. A multidimensional perspective implies that the same observable performance can be reached by different means.

I return now to the question of what constitutes a constructivist approach (or, more precisely, a constructive rationalist approach) to individual differences – whether inter- or intra-individual differences. In my opinion, the key principle is that one consider psychological process vari-
ables within the subject to be responsible for individual differences, through active interactions with aspects of the environment. From a constructivist perspective, there cannot be a direct link between external variables and subjects’ observable performances. Thus, one must look for, and try to define, psychological variables (organismic processes) within the subject that mediate the influence of these external elements. Social class or educational practices cannot directly influence performance on a cognitive task, but they can trigger psychological mechanisms that are responsible for cognitive development. Lautrey’s [1980] work on the influence of socio-economic class on cognitive development is a good example of such an approach. It demonstrates how educational practices provide opportunities for regulations, as defined in Piaget’s model of equilibration.

The schema presented in figure 2 depicts in a very simplistic manner interactions between organism and environment from a constructivist perspective. It shows that there is no direct link between environment and performance. It should also be stressed that the type of interactions with the environment changes as subjects construct increasingly more complex structures; that is, there is a recursive interplay.

Drawing heavily on Pascual-Leone’s [1969, 1987] suggestions, I can now distinguish different levels of organismic processes. [For a discussion of deep structure vs. surface distinctions within neo-Piagetian models, see Dassen and de Ribaupierre, 1987]. I will also elaborate further on various developmental and differential mechanisms within the subject. Figure 3 contains an oversimplified representation of such mechanisms and of their combined actions, but it conveys the complexity of processes that has all too often been overlooked in developmental psychology. Pascual-Leone [Pascual-Leone, 1969; Pascual-Leone and Goodman, 1979; Pascual-Leone et al., 1978] suggests distinguishing at least three levels: (a) a level of

Table 1. Theoretical patterns of passes and failures for subjects A and B in figure 1 in a cross-sectional study conducted in the middle of this developmental period.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Task</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

observable performance, for instance the judgment in the well-known conservation task, that the mass of a ball of clay and of a sausage of clay are equivalent; (b) an underlying scheme or structure, for instance the scheme of an identity-preserving transformation, and therefore of invariance, in the same task, and (c) content-free processes or basic capacities.

The second level embodies the Piagetian notion of structure; it is composed of invariances or representations that the subject has actively constructed. These structures may or may not take the same form in different domains and in different subjects. Presuming the existence of severe developmental constraints, their form is probably common to a broad range of subjects or situations. Case’s conceptual structures [Case and
There is no one-to-one correspondence between levels. Most performances are multidetermined by several schemes and several basic processes. Clear assessment of the influence of a single process, such as the developmental mechanism, requires carefully constructed experimental paradigms and/or selected subjects [Pascual-Leone, 1970, 1978; de Ribaupierre and Pascual-Leone, 1984]. Conversely, to single out the influence of a differential mechanism, subjects of the same developmental level should be selected and compared across tasks of equivalent complexity.

Furthermore, the same observable performance may be produced by activation of different schemes for different subjects, or even for the same subject on different occasions. For instance, in figure 3, the same observable performance y is shown to result from either a combination of schemes b and c or a combination of schemes b and d. Finally, the same scheme may be constructed in different ways for different subjects. In figure 3, for instance, scheme a is activated either by the developmental process α and the differential process β or by the developmental process α combined with the differential process δ. This complex interplay between processes and the differential case with which different subjects can apply different processes has also been described by Reuchlin [1978], under the label of ‘vicarizations’.

Empirical Illustrations

Individual Differences in Modes of Processing

I now describe two lines of research to illustrate how developmental and differential aspects can be, at least partially, disentangled, but also how complex this separation may prove to be. The focus of our first program of research [Rieben et al., 1983, 1986; Lautrey et al., 1985] was not only the magnitude but also the form of intra- and inter-individual variability in operational development. One of our objectives was to determine to what extent development could be considered unidimensional and, if not, which forms it could take. For this purpose, we administered a set of eight operational tasks, somewhat modified from the original Piagetian version, to children aged 6–12. We also conducted a longitudinal follow-up 3 years later [de Ribaupierre et al., 1991]. The tasks are representative of four conceptual domains – logico-mathematics, physics and geometry, space, and mental imagery.

The definition of structural correspondences between levels of performance (and hence the establishment of a common scale) was considered a
prerequisite for the study of synchronism across tasks and therefore for the
study of individual variability. Because the Piagetian framework does not
provide a way to establish structural correspondences between interme-
diate behaviors, we developed the concept of dimension of transformation,
which was designed to permit an analysis of both task complexity and
subject's performance. This concept is closely related to Piaget's concept of
scheme or to Siegler's [1981] rules. The structural invariants postulated
consist of the number and degree of articulation of the dimensions that a
task required, despite variations in content.

According to the rational task analyses we conducted [Rieben et al.,
1983, 1986, 1990], the tasks that we presented required from one to three
dimensions of transformation. Subject's performances (whether judgment,
ments, productions, and/or verbal arguments) were analyzed as a function
of the emergence and growing articulation of dimensions, allowing us to
define six ordered levels of performance [Rieben et al., 1983]: (1) no
dimension of transformation (no transformation imposed on the input);
(2) emergence of a first dimension of transformation; (3) emergence of a
second dimension of transformation, not articulated with the first one, i.e.,
disjunctive; (4) articulation of the two dimensions; (5) emergence of a third
dimension if relevant, but not yet articulated with the two preceding ones,
and (6) articulation of three dimensions. With respect to the model shown
in figure 3, a dimension of transformation belongs to the second level. It is
not observable but is inferred from subjects' performance and accounts for
a number of different performances. It may, just like a scheme, coincide
with a subjective representation or scheme. However, it is safer to assume
that it merely represents an observer's description of the subject's be-

Each of the six preceding levels (i.e., the number and degree of articu-
alation of dimensions applied) is understood as a structural invariant
that serves to describe the formal property of thinking in different situations (a
developmental invariant) as well as to represent the complexity of the task
(situational structural invariant in terms of complexity). Thus, levels are
descriptive, although they have been inferred and are of course not obser-
vable. The fact that subjects are limited to applying only one dimension
could be due to an underlying developmental process of attentional capa-
city that constraints the number of units that can be processed. Certainly
there is no one-to-one matching between the number of units processed by
the subject and the number of dimensions applied. The correspondence is
more complex, but this is not the point to be made here. The universality

of such structural invariants is of course more limited than that of the
Piagetian structures; still they are applicable to a relatively broad content
area.

Most performances are multidetermined, including those scored in
terms of structural levels (with the exception perhaps of tasks that are
carefully controlled, which Piagetian tasks are not). Synchronism was
therefore not expected. Heterogeneity could be anticipated for two rea-
sons: (a) the importance of situational or contextual aspects for all subjects,
and (b) individual differences in the activation of underlying psychological
processes. First, the components of a task can be made more or less easily
accessible; they can, for instance, be embedded in the context, as in mis-
dimension might then be easier to apply in one task than in another, even
when both tasks entail the same number of dimensions, with a resulting
decalage observed for all subjects. After Longeot [1978], this type of decal-
age was labeled 'collective decalage' [Lautrey et al., 1985].

A second source of variation is the ease with which subjects apply a
certain number of dimensions in particular situations. Two subjects who
are at the same general cognitive level can differ in the structural level at
which they function in a particular context. One subject might apply two
articulated dimensions, whereas the second one might apply only one
dimension. This difference could be due to a number of factors other than
rate of development, such as greater sensitivity to field effects, previous
experience in similar contexts, or motivation. As a result, intra-individual
patterns differ for different subjects. Hence, only an extensive study of
different forms of decalage can address the issue of individual differences.

A number of analyses were performed to determine the types of decal-
ages that could be observed [Rieben et al., 1986]. Results led to the hypo-
thesis that at least two different modes of processing were relevant to the
tasks, related to the distinction introduced by Piaget [Piaget and Inhelder,
1947; Lautrey et al., 1985] between logico-mathematical and infra-logical
tasks. The two modes are the propositional and the analogical ones. They
were considered equivalent in complexity and thus were not assigned a
'developmental value', even though they may also correspond to develop-
mental factors.

In line with Reuchlin's [1978] suggestion, the two modes were regarded as vicarious, that is, they were presumed to coexist in a subject
and to offer alternative methods of approaching many tasks (at least up
to some point in development). At the same time, however, they were
considered as linked to situations. That is, situational characteristics were assumed to differentially elicit one mode or the other, because the digital or propositional mode is more adequate for handling discrete problems such as logico-mathematical tasks, whereas the analogical mode is more appropriate for treating continuous problems such as infra-logical ones. Optimal functioning probably depends on an interaction between type of situation and mode of processing and therefore on a flexible use of each mode. Flexibility in employing one mode or the other is susceptible to individual differences, since subjects might develop, probably in a cumulative manner, a preference for, or bias toward, one mode over the other. These individual differences in accessibility and flexibility of processing modes were hypothesized to contribute substantially to the different intra-individual patterns observed at a given developmental level.

Table 2 illustrates extreme cases of decalage. It shows the pattern of pass/fail scores for two types of subjects on some items. Both the items and the subjects shown are those contributing the most to a group factor contrasting logico-mathematical and infra-logical items in an analysis of correspondences, similar to a factor analysis [Lautrey et al., 1986]. Some propositional subjects pass very difficult logico-mathematical items, such as the last two items solved by only 12% of the sample, while failing relatively easy infra-logical items (solved by 45% of the sample). In contrast, some analogical subjects solve difficult infra-logical items while failing easy logico-mathematical ones. The difference between the two types of subjects was not linked to age.

The two modes of information processing can be regarded as resulting from differential mechanisms, not developmental ones. They probably occupy a position intermediate between the process and the structure level (i.e., between the second and third level) in figure 3. Like cognitive style variables, modes of processing indicate which mechanisms are in operation in a given type of subject.

According to the classification suggested earlier, this study, and the conclusions to which it led, represent an instance of the fourth way in which individual differences can be treated. The focus is on intra-individual variability after developmental factors have been, at least partially, controlled for by defining equivalent structural levels across tasks. From this perspective, individual differences are regarded as factors that are orthogonal to developmental ones and that generate different developmental pathways.

Table 2. Examples of extreme patterns of performance on selected logico-mathematical and infra-logical items [adapted from Lautrey et al., 1986]

<table>
<thead>
<tr>
<th>Subject's gender/age</th>
<th>Logico-mathematical items</th>
<th>Infra-logical items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Subjects passing items:</td>
<td>100</td>
<td>76</td>
</tr>
<tr>
<td>Percentage of passing:</td>
<td>65</td>
<td>49</td>
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<table>
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<tr>
<th>Propositional subjects</th>
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<tbody>
<tr>
<td>M/7</td>
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<tr>
<td>M/9</td>
</tr>
<tr>
<td>M/9</td>
</tr>
<tr>
<td>F/12</td>
</tr>
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<td>M/10</td>
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<table>
<thead>
<tr>
<th>Analogical subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>F/11</td>
</tr>
<tr>
<td>M/12</td>
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<tr>
<td>F/10</td>
</tr>
<tr>
<td>M/12</td>
</tr>
<tr>
<td>F/6</td>
</tr>
</tbody>
</table>

Note: 1 stands for a pass score and 0 for a fail score. Items and subjects are ordered as a function of their decreasing contribution to the factor in correspondence analysis.

Individual Differences in Speed of Executive Learning

A second empirical illustration is based on an ongoing study of the development of attentional capacity in children [de Ribaupierre et al., 1989, 1990, 1991; de Ribaupierre and Spira, 1991; Spira et al., 1989]. It reflects the third approach in the earlier classification. The focus is on developmental change, using Pascual-Leone's and Case's experimental tasks, which include controls for individual classification. The present example is also intended to demonstrate how, even when carefully controlled experimental paradigms are used, individual differences continue to creep in, making it all the harder to dissociate developmental and differential aspects of performance.

The objective of the study was to test longitudinally the existence of the developmental stages postulated but only cross-sectionally validated by
In line with the main argument of the present chapter, the results demonstrate once more the great difficulty of uncovering true developmental processes. They could of course be interpreted as a challenge to Pascual-Leone’s model, but things seem somewhat more complex, since results for the first year were concordant with his predictions. To say the least, the results indicate that the CSV1 is not a ‘pure’ M task and that the simplifying postulates adopted by Pascual-Leone in his CSV1 model no longer hold in a longitudinal study. The more frequently the task is repeated, the higher the weighting of components that are sources of individual variability. In particular, it is probable that in the second year, and a fortiori the third year, the postulates relating to equivalent learning and executive strategies among subjects are violated. Having had some experience with the task, subjects are likely to resort to systematic scanning and response strategies, which together can be construed as executive learning and are highly susceptible to inter-individual differences. It should be noted that no control of individual differences was implemented in selecting the samples, probably adding to the inter-individual variability. Thus, a longitudinal design increases the effect of differential processes relative to developmental ones in this type of task, making difficult to assess the existence of general developmental stages. Stages must be shown to correspond to developmental changes and not only to developmental differences [Hoppe-Graff, 1989; de Ribaupierre, 1989b]. If a theory that postulates general stages is not to become irrefutable, a specific methodological model must be devised for longitudinal studies. Different but equivalent tasks could be used on different testing occasions, to avoid the interference of retest effects. However, there is then no guarantee that one is examining the same competencies across occasions, given the enormous situational variability repeatedly demonstrated in the literature. The theoretical and empirical equivalence of such tasks must first be demonstrated.

Conclusion

The main objective of the present chapter was to demonstrate how developmental and individual differences are irredeemably mingled in most research. Most developmental models have tended to ignore individual differences or to consider them as mere variations around a norm [Reuchlin and Bacher, 1989]. I have argued that an attempt should be made to conceptualize individual and developmental factors as orthogon-
al. I have also argued that individual differences may be due not only to external causes such as environmental variability, but may also originate in differential processes within the subject. When focusing on the extent and form of intra- and inter-individual variability, it is necessary to first define structural invariants that allow comparison across tasks and subjects. Reciprocally, to highlight developmental factors, one should control for individual differences by using carefully constructed paradigms and/or selecting specific subjects. When using a longitudinal design, even more controls should be implemented.

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