Variability and cognitive development - Commentary

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In their paper, Lautrey and Caroff (1996) make a plea for a pluralistic approach to cognitive development, wherein developmental change is considered to be driven by several processes in interaction, and not simply by one general mechanism. The logical consequence of such a perspective is that all children do not necessarily follow the same developmental path. I can only be sympathetic to such an approach, so much more so that this framework was also developed on the basis of a research programme that we had in common, Jacques Lautrey, Laurence Rieben and myself (e.g., Rieben, de Ribaupierre, & Lautrey, 1983, 1990; de Ribaupierre & Rieben, 1995; de Ribaupierre, Rieben, & Lautrey, 1991). Indeed, we have defended this position for a long time and empirically showed, using a number of Piagetian tasks, that intra-individual variability is very high and can only be accounted for by a model that postulates different developmental paths. We then hypothesized, in congruence with distinctions suggested in cognitive psychology, that there exist at least two modes of processing, an analogical mode and a propositional mode, which should be considered as vicarious processes, in the same sense that Lautrey and Caroff develop in their current article.

I am also very much in line with their attempt to bridge the gap between different disciplines, or subdisciplines, by showing that interest in individual differences is not specific to differentialists but is shared by cognitive psychology, connectionist approaches, and evolutionary biology researchers. I consider, together with Lautrey and Caroff, that it is time that individual differences in cognition be considered by developmental or cognitive psychologists as something else than mere noise or of interest only for applied purposes.

I would like to extend the list to other sub-disciplines, in particular to adult life-span approaches. For instance, in an influential paper, Baltes (1987) has made a number of theoretical propositions, two of which are

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very much in line with the suggestions of Lautrey and Caroff, as well as with the whole francophone, differentialist approach (e.g., Lautrey, 1995; Reuchlin, Lautrey, Marendaz, & Ohlmann, 1990). These are the concepts of multidimensionality and multidirectionality: “The terms multidimensionality and multidirectionality are among the key concepts used by life-span researchers to describe facets of plurality in the course of development and to promote a concept of development that is not bound by a single criterion of growth in terms of a general increase in size or functional efficacy” (Baltes, 1987, p. 614). Not only is the similarity between these concepts and the hypothesis of different individual paths of development in children striking, but it is noteworthy to remark that Baltes has also, more recently, attempted a rapprochement with evolutionary biology (e.g., Baltes, Lindenberg, & Staudinger, in press), and particularly so with respect to the issue of selection. This recent integration is all the more interesting as life-span approaches, although inter-disciplinary by nature (e.g., Baltes, 1987), have traditionally established closer links with sociology (or with medicine as concerns health issues) than with biology, inasmuch as they stressed the importance of context. Note, however, that the links established thus far in this perspective with evolutionary biology pertain more to the concept of selection as it applies to aging in human species, in interaction with the role of culture, than to individual differences.

To view cognitive development in terms of multidimensionality also has the advantage of linking developmental research with psychometric research, out of which, incidentally, a number of life-span theories have grown. For instance, the models of Cattell or Horn (e.g., Cattell, 1971; Horn, 1989) consider intelligence as consisting of several subcomponents (multidimensionality) that are expected to differ in the direction of their development (multidirectionality). Psychometric approaches using Piagetian tasks have shown a similar structure (for a discussion, see Lautrey, de Ribauipierre, & Rieben, 1990).

The proposal to link these two sub-disciplines is, of course, very old (e.g., Reuchlin, 1964), but has taken a number of years to be empirically instantiated. Although there has been an increasing tendency to consider individual variability as a fundamental facet of development, there are not yet many developmental theories that postulate the existence of vicarious processes. In particular, I believe that there are not yet enough theories that consider, like Lautrey and Caroff, that individual differences are not solely determined by the environment (see also de Ribauipierre, 1993).

Based on Reuchlin (1978), Lautrey and Caroff describe five characteristics of vicarious processes, and suggest some slight modifications (propositions 6–9). Although most of the suggested modifications were already contained in Reuchlin’s original formulations, Lautrey and Caroff elaborate further on these points and distinguish more clearly between the characteristics that may contribute to individual differences and those that may contribute to development, resulting in a dynamic model of development. Perhaps, the model would gain in scope if the authors were to analyse more thoroughly the type of interaction that may occur be-
tween the processes, and, in particular, to distinguish more explicitly between complementary and incompatible relationships. This distinction would probably lead them to take into account the role of inhibition (see below), which certainly belongs to the repertoire of vicarious processes.

It is only fair to stress that Pascual-Leone's theory has, for a long time, insisted on the necessity of defining several underlying processes, which are present in all individuals and susceptible of vicariances, even though he does not explicitly use the term vicariances. As early as the end of the sixties, Pascual-Leone (1969, 1970) defined a number of "silent operators" that jointly contribute to performance by boosting the activation weight of schemes present in a subject's repertoire. His model is also an intrinsically dynamic one: schemes are defined as informational units with their own activation weights that can be further boosted by the underlying processes, a proposal that is very much in line with present day connexionist approaches. Furthermore, Pascual-Leone explicitly states a number of possible relationships between the mechanisms involved and describes how performance is finally determined by the cluster of schemes that gets the highest weight, through a process labelled Schematic Overdetermination of Performance (SOP principle; see, e.g., Pascual-Leone, 1969; Pascual-Leone, Goodman, Ammon, & Subelman, 1978; de Ribaupierre, 1983).

With their empirical illustration, Lautrey and Caroff address the controversy raised by the role of identify arguments in the classical conservation paradigm. According to the "classical" developmental interpretation, three levels would be observed in non-conservers, specifically when asked to anticipate whether pouring liquid from a wider to a narrower glass has an effect on the level and on the quantity of liquid; (a) "pseudo-conservers" anticipate that both level and quantity remain invariant; (b) "classical non-conservers" (later termed "dimensional" by Lautrey and Caroff) anticipate that both variables change, and (c) "identity generalizers" predict that quantity changes while nevertheless being able to say that the level also changes. It is important to stress that all three types of children still do not conserve when confronted with the actual pouring of the liquid, whether in identity or equivalence conservation tasks. Lautrey and Caroff propose that these three types of responses do not reflect developmental levels, but rather individual differences in the stress placed on either the identity transformation or on the change in dimensions. Their first experiment showed in two ways that the hypothesis of three developmental levels is not upheld. First, in all three groups, the modal tendency was stability. One could of course argue that three months was not a sufficient interval of time for developmental change to take place. One would nevertheless have expected that the "progression", when there is one, be regular; that is, from pseudo-conservation to dimensionality on the one hand, and from dimensionality to identity generalization, on the other. This pattern was not observed. Moreover, and more convincingly, there were as many pseudo-conservers as dimensional children who became generalizers or even conservers. It is also worth stressing, however, that a higher proportion of "identity" children (almost 25%) became conservers as compared to either of
the other two groups (less than 15%). This difference is probably not significant, but may nevertheless point to the fact that "identity generalization" might be developmentally more advanced than either pseudo-conservation or dimensionality (the latter two patterns being equivalent). This is the position which will be adopted below. It nevertheless tends to show that at least two of the three levels, that is, pseudo-conservation and dimensionality are equivalent rather than developmentally ordered. Incidentally, how the authors tested their "model" is unclear, and one wonders whether it was it by means of prediction analyses.

In their second, and more novel experiment, Lautrey and Caroff address not only the existence of different types of responses, but also another controversial issue in the conservation literature, namely the difference between the identity and the equivalence paradigms. It has long been shown (e.g., Elkind & Schoenfeld, 1972) that the identity paradigm, in which there is only one quantity of liquid being transferred from one glass to the other (or only one ball of clay being transformed, in the case of conservation of substance), is easier than the traditionally used equivalence paradigm. The authors do not address the issue of difference in complexity between the two situations, but suggest that the equivalence paradigm induces more dimensionally based responses because the misleading dimension (the height of the liquid) is more salient. They predict, therefore, that children should anticipate a greater difference in quantity in the equivalence situation, and that "dimensional" children should be more sensitive to the difference of paradigm. This indeed what they observe. One can perhaps question whether the number of subjects in each experimental group was sufficient to provide reliable results, so much more so that no statistics are provided. Nevertheless the predicted interactional pattern is obtained. Thus, the results tend to support nicely the authors' hypothesis that children follow different routes or paths toward conservation.

There are, however, two slight problems with their theoretical account of the empirical results. First, it could be argued that the term "processes" is ill-used in the present case. Second, although the results show that there is not a single route to the acquisition of conservation, the authors still do not tell us why children do not conserve, or why they will eventually all reach conservation.

With respect to the first issue, Lautrey and Caroff seem to consider that "identity generalization" or "dimensionality" (i.e., reasoning on the apparent dimensions of the containers) are processes, similar to the processes or the modes of processing that they referred to in the theoretical introduction. I would prefer to consider them as pieces or chunks of knowledge, or even better as schemes in the Piagetian sense; that is, invariants that have been extracted from the environment. This reconceptualization is particularly appropriate for the "identity generalization". As a matter of fact, this point of view is even explicitly stated by the authors since they say that the child can "observe that objects generally preserve [objects] perceptual properties when they change places or shapes; objects remain the same color, texture, temperature, etc. Children may therefore infer [underlined by this author] that some more abstract properties that they do not perceive, such as quan-
tity, are also preserved”. This is typically the definition of invariants given by Piaget. That children “decide” to favor the one or the other scheme does in turn depend on underlying processes, which are indeed most probably vicarious. I would have preferred the authors to offer us a hypothesis as to the nature of the underlying processes that drive this choice. Later, in their discussion of identity generalization, they refer to an analytic versus a more global aspect. Perhaps the analytic-global distinction would have been a promising avenue to pursue, so much more so that Lautrey has conducted work in this direction (e.g., Pacteau, Bon-thoux, Perruchet, & Lautrey, 1994). It would also have been closer to the concept of modes of processing introduced in the first part (see also Rieben et al., 1990; de Ribaupierre & Rieben, 1995). Whether modes of processing are really processes or also schemes might be yet another issue of controversy. But this issue is beyond the scope of this commentary.

As to the second issue (i.e., the acquisition of conservation), I would like to use the present results to advance an alternative, perhaps more speculative explanation, one that is somewhere between the traditional, developmental explanation, and the Lautrey and Caroff perspective, which, in the present case, is solely differential. Without entering the controversy of what is “true” conservation (e.g., the controversy opposing Piaget to Bruner mentioned by Lautrey and Caroff), the minimal definition of conservation reasoning is that the invariance in quantity be abstracted despite the change in dimensions. That is, it requires integrating the two schemes mentioned above, or the two processes analyzed by Lautrey and Caroff. Following a number of neo-piagetian authors (e.g., Case, 1985; Pascual-Leone, 1987), my suggestion is therefore that young children cannot integrate these two pieces of information due to their limited resources, be it working memory or attentional capacity (Chapman, 1990; de Ribaupierre, 1995a, 1995b; de Ribaupierre & Bailleux, 1995). It is the growth in processing resources that accounts for the acquisition of conservation, this growth being more or less universal. Therefore, at one point or another, when their resources are sufficient, all children will use these two schemes. However, some will first focus on the change in dimensions, while others will first stress the identity aspect. In terms of developmental levels, this implies the following modification with respect to either the traditional developmental explanation or to Lautrey and Caroff’s account. I am referring here to the three patterns (patterns a, b, and c) described by Lautrey and Caroff with respect to the anticipation questions. At a first level, children would either focus on the dimension and predict that there is more to drink, or focus on identity and anticipate that nothing changes (pseudo-conservation); that is, in conformity with Lautrey and Caroff’s proposal, patterns a and b should indeed not be developmentally ordered but should be considered indicative of individual differences. Pattern c, in contrast, corresponds to a slightly more advanced level: Children begin to take both variables into consideration simultaneously; however, they can only do this when they are not confronted with the actual pouring of the liquid. That is, the two schemes co-exist, but are not yet integrated.
into a single reasoning and the identity scheme is still dominant. As a result, children can anticipate that the quantity will remain the same, but also say that the level of the liquid will be higher; the latter prediction usually only occurs upon questioning. It is only when the two schemes are both fully co-ordinated that a conservation response will be given. This conserving response would thus constitute a fourth level, the one studied in either the identity or the equivalence situations, in contrast with the anticipation questions.

The difference between the two paradigms of conservation remains yet to be explained. The account given by Lautrey and Caroff is that the equivalence paradigm calls more strongly for a dimensional or an analytic process. Their hypothesis is certainly true, but conserving in the equivalence situation probably requires both remembering that the two containers had the same quantity before the transformation and attentionally disregarding the difference in height; hence, a larger amount of information to be processed. The temporal lag between identity and equivalence would therefore be due to the time necessary for a further increase in processing resources, as well as to the necessity to actively inhibit the irrelevant information (for a discussion of the concept of inhibition in development, see Dempster, 1991, 1992; Dempster & Brainerd, 1995; Houdé, 1995; Pascual-Leone, 1987; Pascual-Leone & Goodman, 1979). Note that my suggestions are very much in line with the structuralist system of dimensions of transformation proposed in our earlier, common work with Lautrey and Rieben (e.g., Rieben et al., 1986). Note also that it is fully compatible with Pascual-Leone’s theoretical analysis, in terms of M-power, of both the conservation situation, and the difference between the identity and the equivalence paradigms (Pascual-Leone et al., 1978). Is this to say that all children follow a same developmental path? Again, my response would be two-fold, or intermediate between the traditional developmental explanation and a purely differential one: Yes, in terms of how much information they can process; no, when it comes to analyzing which information is being processed and how. Therefore, although the present proposal reintroduces a developmental order (albeit only a partial order) between the three patterns described by Lautrey and Caroff, it emphasizes just as much the necessity to adopt complex models of development which integrate the concept of vicarious processes.

REFERENCES


