Commentary

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We have found the exchange between Mulaik and Mumford thoughtful and interesting, and the only winner we are prepared to declare is the developmentalist whose own thinking is clarified and whose research is improved by the arguments presented in the exchange. It is our hope that there will be many such winners.

Mulaik and Mumford's arguments emphasize two general matters. The first concerns the distinction between exploratory and confirmatory analysis, and the second involves the definitions and empirical evidence needed to establish persuasively various conceptual entities such as types and developmental trajectories. Our own view is that relatively little additional comment is necessary concerning the first matter. We subscribe to the view that, although the line drawn between them is occasionally fuzzy, exploratory and confirmatory research have quite different immediate objectives. Each approach, however, can further the use of the other one in valuable ways [e.g., the inductive-hypothetico-deductive spiral of knowledge development described by Cattell, 1988; also see Schaie, 1988, for specific examples]. The path to resolution of the second matter is somewhat less clear, but it is of singular importance to developmentalists.

As the content of the protagonists' remarks show, the two matters are not necessarily unrelated. Both have interesting theoretical, methodological, and philosophical aspects. It is our sense that many (but not all) developmentalists are interested in the aspects in the order mentioned.

Confirmatory versus Exploratory Analysis

First, consider the matter of confirmatory versus exploratory research. A careful reading of both Mulaik's and Mumford's papers indicates a great deal of agreement. Both authors acknowledge the value of articulating hypotheses that have significant theoretical implications and then testing those hypotheses under conditions that permit their falsification. Both Mulaik and Mumford seem to agree that a science involves progressive refinement of representations of relationships among variables. The disagreements between Mulaik and Mumford re-

garding this matter seem to center on two major points. One concerns the question of what constitute suitable data for testing versus formulating hypotheses, and the other has to do with how much information is to be amassed to justify making initial inferences about explanations of events. An ideal in hypothesis testing is use of data that are completely independent of those on which hypothesis development rests. Data sets, however, often contain much more information than is ever extracted from them. Checking for additional consistencies with hypotheses in unexploited nooks and crannies of one's extant data set, while not a giant step toward replication and confirmation, is at least a small step in that direction, the value of which can be substantial

There seems to be no objective way to decide when one has enough information to justify the articulation of hypotheses by promulgating conceptual entities such as types or developmental trajectories. On the one hand, it is easy to reify concepts prematurely. On the other hand, until one begins to take concepts seriously, they are unlikely to receive the challenging scrutiny necessary to reject them. It seems here that Mumford is willing to base his inferences about such abstractions on less information than Mulaik is prepared to accept.

Establishing Types, Trajectories, and Other Abstractions

The second matter identified above – defining and establishing operational expressions of concepts such as types and developmental trajectories – is a critical one for developmentalists and is considerably more in dispute between Mulaik and Mumford.

There are four points that we wish to make in this regard.

First, developmentalists (and learning theorists, for that matter) have distinguished between a series of events that reflects developmental or other processes and several events that happen in a sequence but are otherwise unrelated to each other. The series of events that reflects one or more underlying processes has, by virtue of those processes, an integrity, organization, or coherence that is in part defined by temporal considerations [Baltes et al., 1977/1988; Featherman, 1985; Ford, 1987]. How to detect, construct, or otherwise represent evidence to justify inferences about this kind of organization is one of the great challenges for researchers. For example, analogous to multitrait-multimethod approaches to the establishment of convergent and discriminant validity [Campbell and Fiske, 1959], multitrait-multioccasion data can provide valuable information concerning stability, continuity, and other aspects of temporal organization. Some kinds of evidence are doubtless more compelling than others, but at this point none should be overlooked or summarily dismissed.

Second, types obtained by clustering or other techniques often are not necessarily temporally defined. Developmental processes, however, always involve the temporal dimension. Thus, it is important that temporal information (and it can take many forms) be involved in the definition of developmental trajectories or pathways. Work on modeling processes such as learning and growth [McArdle, 1988] has helped to develop types that are defined in terms of temporal characteristics of data. Careful and critical use of such approaches can provide more rigorous support for modal develop-

mental change patterns than that offered by atemporal data.

Third, although some sophisticated thinking has been aimed at appropriate re-presentation of process, there is no consen-sus on the final solution. Stability and pre-dictability have played central roles in at-tempts to elucidate developmental concepts. It seems fair to say, however, that an empha-sis on simple phenotypic stability has been usefully supplanted by conceptions of stabil-ity that are far more abstract [Kagan, 1969; Labouvie, 1980; Wohlwill, 1973]. In person-ality development, the trait/state distinction helps to illustrate the point. Evidence for trait and trait development has rested heavily on stability arguments (e.g., autore-gressive models). State and state change also represent processual changes, but stability coefficients cannot be relied upon to demon-strate their integrity [Hertzog and Nessel-roade, 1987]. Clearly, stability in some form is a necessary backdrop for identifying change, but the form of that stability can be considerably more complex than high test-retest correlations or invariance of factor patterns.

Fourth, it is important to attempt to move beyond merely showing correlation and covariance patterns to provide other evidence for coherence and integrity of con-cepts. For decades, researchers have argued for the need to augment correlation-based concepts with manipulative research, where possible. The use of causal-structural models to examine the plausibility of hypothesized causal chains offers additional possibilities by which developmentalists can explore the limits of integrity and coherence of their pre-ferred conceptual entities.

Theoretical and empirical work aimed at improving our ability to represent develop-mental phenomena is sorely needed. Suc-cesses, when they occur, will be due in part to bold inference and in part to careful, con-servative, empirical research. If we knew when to rely most heavily on which, we could greatly facilitate the advance of scien-tific knowledge. We don't. It seems impor-tant that both lines of activity be main-tained, with the former continuing to stimu-late more of the latter and the latter ulti-mately rendering the verdict on the validity of the former.

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