Dynamical cognitive models and the study of individual differences

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A large part of psychology concerns the study of individual differences. Why do people differ in personality? What is the structure of individual differences in intelligence? What are the roles of nurture and nature? Researchers in these fields collect data of many subjects and apply statistical methods, most notably latent structure modeling, to uncover the structure and to infer the underlying sources of the individual differences. Cognitive science usually does not concern individual differences. In cognitive models we focus on the general mechanisms of cognitive processes and not the individual properties.

We believe that these two traditions of modeling cannot remain separated. Models of mechanisms necessarily precede models of individual differences. We argue against the use of latent structure models of individual differences in psychological processes that do not explicate the underlying mechanisms.

Our main example is general intelligence, a concept based on the analysis of group data. Scores on cognitive tasks used in intelligence tests correlate positively with each other, i.e., they display a positive manifold of correlations. The positive manifold is arguably both the best established, and the most striking phenomenon in the psychological study of intelligence. Over the past 100 years differential psychologists have sought to explain this phenomenon by invoking an underlying general intelligence factor, associated with a single quantitative cognitive or biological process or capacity. At present, the factor analytic (statistical) support for a general factor is considered strong. However, the nature of the *g*-factor remains unclear.

Here we discuss a new explanation of the positive manifold based on a dynamical model, in which reciprocal causation or mutualism plays a central role.

We developed an abstract mathematical model for mutualistic development. It is shown analytically and by simulations that the positive manifold emerges purely by positive beneficial interactions between cognitive processes during development. A single underlying g-factor plays no role in the model.

The model offers explanations of important findings in intelligence research, such as the hierarchical factor structure of intelligence, the low predictability of intelligence from early childhood performance, the integration/differentiation effect, the increase in heritability of *g*, and the Jensen effect, and is consistent with current explanations of the Flynn effect.

We believe and will argue that similar models can be developed for other typical latent variable explanations in psychology, such as clinical disorders and personality traits. Such models do not only increase our understanding of these phenomena but also imply new types of interventions. In more complex dynamical systems interventions can have counterintuitive effects.

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