Developmental analyses of individual differences in intelligence: Comments on Demetriou et al. (2013)

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1. Introduction

The work reported by Demetriou et al. (2013) makes a substantial, innovative, and provocative contribution to the developmental analysis of individual differences in intelligence. In this Commentary, I mention three reasons why the work of Demetriou et al. is so valuable to the literature. Then I suggest three directions the work could take to provide additional insights into the developmental paths that individual children follow as they achieve mature levels of the reasoning skills that comprise fluid intelligence.

1. Why is the Demetriou et al. work so valuable?

1.1. Sophisticated methods

In many respects, the Demetriou et al. work could serve as a poster child for the advanced methods that are best practices in modern developmental science. First, they use multiple longitudinal studies, each with large samples. Second, they do not rely on raw scores alone; instead, they use structural equation modeling to estimate latent constructs for processing speed, working memory (WM), and fluid intelligence, based on children's performance on an extensive battery of tasks. Third, they use methods devised recently (Salthouse, 2012) to examine developmental change in the level at which change operates. With these methods, Demetriou et al. can determine the relative impact of developmental change in basic processes versus change in higher-order processes.

1.2. Powerful, integrative theory

Traditional developmental theories—with Piaget's being the prototype—paid scant attention to individual differences in cognitive skill; such differences were acknowledged but thought to be of little interest (Flavell, 1963). Similarly, traditional psychometric accounts of intelligence tend to discount developmental differences; the fact that adult IQ scores are well predicted by scores obtained at 5 or 6 years of age was interpreted to mean individual differences in intelligence were well established by the time children enter elementary school (Anastasi, 1960).

More recent theories within developmental and differential psychology (e.g., Case, 1985; Gardner, 2006) have put greater emphasis on the individual developmental pathways that lead to adult levels of intelligence. But the Demetriou et al. work is unique in arguing that the same mechanisms can account for developmental change and individual differences. They draw upon theories developed by cognitive, developmental, and differential psychologists (e.g., Cerella & Hale, 1994; Engel, Tuholski, Laughlin, & Conway, 1999; Salthouse, 1996) to explain reasoning skill in terms of a cascade of processes: more rapid
processing allows working memory to be used more efficiently, thereby enabling more extensive problem representations that contribute to successful performance on complex reasoning problems. In other words, systematic variation in processing speed and working memory can be used to account for age-related change in reasoning skill and individual differences in the rate of that change.

1.3. Provocative findings

The Demetriou et al. report is filled with many thought-provoking outcomes. For example, although speed, WM, and fluid reasoning all change steadily with development, perhaps with some plateaus (their Figure 4a), the age-related changes in level of performance are accompanied by qualitative change in the structure that best describes links between them (their Figure 3): The data for the youngest children are best described by a model in which speed predicts a common factor that includes WM and reasoning; for school-age children, separate but related speed and WM factors predict reasoning; for adolescents, the full cascade model emerges, with speed predicting WM, which, in turn, predicts reasoning.

2. Ways to increase the impact of this line of work

2.1. Extend the developmental trajectory

Demetriou et al. focused on school-age children and adults, an age range that is relatively easier to study (e.g., in the preschool children sample in Study 1–4-year-olds—a majority did not pass the screening tasks and were dropped from the study). But the impact of this work would be enhanced, as Demetriou et al. note, by extending the age range. This is certainly feasible, in terms of theory and method. For example, Salthouse (1996) and others have used much the same conceptual framework to examine the impact of speed and WM on age-related declines reasoning skill. In addition, Rose and her colleagues (e.g., Rose & Feldman, 1995; Rose, Feldman, & Jankowski, 2012; Rose, Feldman, Jankowski, & Van Rossem, 2012) have studied the role of basic processes like processing speed and memory in the development of higher-order cognitive processes in infants and young children. For example, Rose, Feldman, and Jankowski (2012) and Rose, Feldman, Jankowski, and Van Rossem (2012) measured several processes, including memory and processing speed, in infants and toddlers. At age 11 years, children were retested on tasks representing different components of executive functioning (shifting, inhibition, working memory) as well as on the WISC-III. The key findings were that processing speed measured during infancy and the toddler years predicted shifting and working memory at age 11 and that memory assessed during infancy and the toddler years predicted working memory and IQ at age 11. Thus, this line of inquiry is one—all too rare in modern psychological science—where theory and methods allow it to be investigated from birth to death.

2.2. Move beyond tests and tasks

Demetriou et al. focus exclusively on scores reflecting performance on an extensive battery of tasks designed to sample a broad range of cognitive skills. This is a sensible starting point, particularly when most of the tasks have been validated in previous work and when they are used with other related tasks to estimate underlying constructs. Nevertheless, the work would be more compelling if other indicators were included in the model. For example, one could add measures of academic skills and school performance, then determine the direct and indirect influences on these measures of processing speed, WM and fluid intelligence. Similarly, for young children, behavioral and parent-report measures of effortful control are related to measures of executive function, which includes WM (Simonds, Kieras, Rueda, & Rothbart, 2007; Wolfe & Bell, 2007). Embedding the present research in a broader nomological network that included a broad range of related constructs such as those mentioned above would reduce the impact of method-related variance and help to establish the external validity of this line of work.

2.3. Explore the full richness of individual variations

In the studies reported by Demetriou et al. individual differences are expressed in terms of linear relations between constructs. This is a reasonable first step but simply scratches the surface in terms of possible analyses of individual differences. As Demetriou et al. suggest (page 46), the link between WM and fluid intelligence may not be linear; similarly, increases in processing speed may yield diminishing returns in terms of WM capacity. But there are certainly other sources of individual variation that warrant scrutiny, sources that exemplify qualitative differences. Do individuals differ in the way that they sacrifice accuracy for speed? Do they differ in the strategies they use to perform tasks that assess processing speed, WM, and fluid intelligence? Do these bases of individual differences change with age? Examining these kinds of individual-difference factors would help to capture the full range of ways in which individual children differ in their performance on tasks that assess intelligence and its supporting processes.

3. Concluding remarks

The issues at hand here—the forces that propel children along the path to sophisticated reasoning and that contribute to differences in pacing along that path—are central to the study of intelligence and to psychological science generally. They deserve our best efforts and the work by Demetriou et al. qualifies in showing the power of linking developmental and differential analyses with a common theoretical framework, a framework that can stimulate additional work on these important issues.

References


