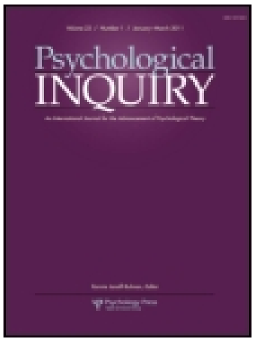

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Commentary on Kovacs and Conway, Process Overlap Theory: A Unified Account of the General Factor of Intelligence

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I appreciate the opportunity to respond to Kristof Kovacs and Andrew Conway's (this issue) target article. As they note, some aspects of their theory are not new. For instance, the strong connection between general cognitive ability and working memory has a lot of support in the literature and is well known by this point. Indeed both researchers have contributed significantly to this literature. However, I'd like to focus on a more novel aspect of their theory, and point out some practical implications.

As they point out, the positive manifold is a well-replicated finding. What still lacks consensus, however, is the explanation for this positive manifold. Their idea that *g* is an emergent property (not the cause) of multiple domain-general executive functions is a novel way of looking at the *g* factor. But to me, the most interesting puzzles they've helped to shed light on are (a) the law of diminishing returns, and (b) the finding that the worst performance on a cognitive test battery is a better predictor of the *g* factor than the best performance. The cause of these two findings has never been satisfactorily explained. Their solution is reasonable: Individual differences in executive processes can serve as a bottleneck for cognitive functioning across a wide range of tasks.

Practically speaking, this solution suggests that it may be more difficult for individuals with executive functioning deficits to showcase their intellectual capabilities. Chuderski (2013) reviewed 26 studies that administered a measure of working memory and a measure of fluid reasoning and found that the studies that increased the time pressure of the fluid reasoning task significantly increased the correlation between working memory and fluid reasoning. In a follow-up experiment, Chuderski found that when participants were required to complete a test of fluid reasoning in 20 min, working memory explained all of the variation in fluid reasoning, whereas when participants were given 60 min to complete a measure of fluid reasoning, working memory accounted for only 38% of the variation in fluid reasoning. This is a big difference! These findings are consistent with other research showing that the processes involved in fast and slow responses can be differentiated (Partchev & De Boeck, 2012). Future iterations of the process overlap theory should address the importance of changes in test administration (e.g., timing) on their theory.

Chuderski also found that a measure of relational learning—that assessed the ability to learn from prior relations to increase efficiency of future processing of relations—predicted variation in fluid reasoning above and beyond the effects of working memory. Taken together, the implication is that tests that relax the demands on executive functioning may give those with executive functioning difficulties more of a chance to bring to bear other cognitive processes—such as relational learning or associative learning (see Kaufman, DeYoung, Gray, Brown, & Mackintosh, 2009)—that may allow them a chance to perform well on complex tests of cognitive ability.

This is a real issue in the learning disability literature. Various learning disabilities, such as dyslexia and attention deficit hyperactivity disorder (ADHD), are accompanied by deficits in executive functioning. For instance, people who exhibit ADHD-like symptoms tend to score lower on tests of working memory (see Kolger, Rapport, Bolden, Sarver, & Raiker, 2010). However, in one recent study, Fugate, Zentall, and Gentry (2013) studied a sample of academically advanced students who either scored in the 90th percentile or above on a standardized test or had a grade point average of 3.5 or greater in a specific academic domain. Students with ADHD characteristics such as "inattention" scored lower in working memory than the students who did not display ADHD characteristics, *even though the groups did not differ in fluid reasoning ability*. How would the process overlap model explain these findings? I think if the model is going to be comprehensive, it needs to explain how it is possible for those with executive functioning difficulties to still be highly intelligent.

The explanation has important implications for how we recognize intelligence in students with extreme scatter in their cognitive profiles. Due to their area of disability, students with learning disabilities tend to score much higher in one cognitive area compared to others. Various researchers are attempting to develop methods for eliminating the attenuating influences of cognitive-processing deficits on an estimate of a child's general cognitive ability (Flanagan, Ortiz, & Alfonso, 2013). It would be great if the process overlap model could help inform real selection decisions that influence the course of a child's future education.

There are also implications for students on the higher end of the IQ spectrum. Multiple studies support the idea that intellectually precocious youth show "multipotentiality"—they tend to show more extreme discrepancies in their cognitive profiles compared to students with average cognitive ability (Achter, Benbow, & Lubinski, 1997; Lohman, Gambrell, & Lakin, 2008). This result suggests that for those with high general cognitive

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ability, their *g* factor scores may mask their particular specific cognitive strengths. I'd like to see future iterations of the process overlap theory further explain the meaning of the general cognitive ability factor among those on the highest end of the spectrum. What's the difference in the cognitive mechanisms that give rise to general cognitive ability among those with an IQ greater than 160 compared to an IQ of 130, for instance?

Finally, it would be great to see how the process overlap theory relates to creativity. Fugate et al. (2013) found that the lower the working memory scores among their population of high-achieving students, the *higher* their creativity. Clearly, creative cognition is a form of intelligence. But it's a form of intelligence that doesn't necessarily always benefit from domain-general executive functions. An interesting future line of research would be to investigate interactions between the executive control network and other networks in the brain. One recent study found that communication between the executive network and the default network contributed to idea generation (Beaty et al., 2015). However, the time course of the task also mattered. The executive network was much more important for later stage processing than early stage processing.

I look forward to seeing how process overlap theory develops and how it makes connections with other areas of psychology, such as educational psychology and creativity research. There is a lot of potential for integration.

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