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Open Peer Commentary

Working memory, executive function, and general fluid intelligence are not the same

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Abstract

Blair equates the constructs of working memory (WM), executive function, and general fluid intelligence (*g*F). We argue that there is good reason not to e
and *g*F as separable but highly related, and suggest that the mechanism behind the relationship is controlled attention – an ability that is dependent on nc

Blair's target article addresses an issue that is of fundamental importance to understanding higher cognitive functioning: What is the relationship between general intelligence? Blair addresses this issue while trying to integrate the fields of behavioral psychology, psychometric intelligence, and cognitive neuro different types of tasks while discussing identical constructs. We argue that although this is a valiant and much-needed effort, more attention must be give *cognition*. Specifically, we believe that working memory, executive function, and general fluid intelligence are not the same.

In his review, Blair examines the relationship between what he calls "fluid cognition" and general intelligence. However, we argue that five separate constr (WM), executive function (EF), general intelligence (*g*) and, related to *g*, general fluid intelligence (*g*F) and general crystallized intelligence (*g*C). Critically, label of "fluid cognition." Unfortunately, there is good reason *not* to equate these three constructs. First, although some evidence suggests that WM and fl al. 2004; Kyllonen & Christal 1990), a great deal more suggests that, although strongly related, WM and *g*F are clearly not isomorphic. Essentially, if the c correlations between latent factors representing these constructs would be consistently near 1.0; in reality, they are closer to.72, indicating approximately et al. 2005; see also Ackerman et al. 2005; Conway et al. 2003; Heitz et al. 2004).

Second, there is evidence to suggest that WM and EF are separable, despite research showing that they, also, are correlated. For example, tasks design Wisconsin card sorting, random-number generation, and Stroop compose a latent factor that is separable from those of WM tasks (Miyake et al. 2000; 20 set switching paradigms (often used as a measures of EF) do not correlate well with WM measures (Kane & Engle 2004; Oberauer et al. 2003); however, prototypical task-switching paradigm, itself, is not a measure of EF (Logan & Bundesen 2003).

To this point, we have argued that WM is not isomorphic with gF, and that WM and EF are related but dissociable. By this view, equating these constructs Equally problematic is the fact that *g* and gF are very highly correlated, and some have argued that they are virtually identical (Gustafsson 1984). Therefo on *g*, we have correlated measures of *g*F such as Raven's Progressive Matrices and the Cattell Culture Fair Test with measures of WM such as reading s Kane et al.2004). We argue that these efforts essentially target the same issue that Blair is concerned with, given that our definition of WM and Blair's def identical. With this in mind, we address research relating individual differences in WM capacity to individual differences in gF.

That WM correlates positively with gF is not controversial. What is under debate is the mechanism for this correlation. Research suggests that one comm (Kane & Engle 2002). For example, human and nonhuman primate studies find significantly reduced WM task performance with PFC lesions that are not & Engle 2002). Similarly, patients with PFC lesions demonstrate a marked deficit in gF-loaded task performance compared to healthy controls (Duncan et

To be specific, our view is that differential functioning of the PFC brings about individual differences in executive attention control. According to our view, t itself not only in high-level cognitive tasks such as those designed to measure gF, but also in fairly low-level tasks, provided that the task requires effortful examples of this, Kane et al. (2001) (see also Unsworth et al. 2004) found that individuals high in WM capacity ("high spans") performed better than those selective orienting task. Specifically, in the antisaccade condition, subjects had to resist reflexive orienting toward a flashing cue and instead execute a sa subjects committed more errors, and, even when their saccade was in the correct direction, they were slower to do so. This result stands in contrast to pe where both high and low WM span subjects were equally able to orient *toward* the flashing cue.

In another such low-level task, Heitz and Engle (submitted) had subjects perform the Eriksen flanker paradigm. Subjects were to respond with one hand i hand if the center letter was S. On compatible trials, all the letters were identical (e.g., SSSSS). However, on incompatible trials, the center letter was surr (e.g., SSHSS). Thus, to perform this task effectively, subjects had to focus their attention (for example, by constraining their attentional allocation) on the surrounding distractor letters. Heitz and Engle (submitted) found that low spans were slower to perform this visual-attention filtering than were high spans the compatible trials, when attentional constraint was unnecessary.

These low-level tasks, though unrelated on their surface to traditional WM-span tasks such as reading span, reliably dissociate low and high WM span pa equation modeling studies, suggest that what is important for high-level and low-level cognitive functioning is the ability to control attention, whether this s letters in the visual field or maintaining a list of letters in a distracting environment. Although we do not yet know exactly how this is important for fluid intel WM and gF, as well as a shared reliance on the PFC, support a view implicating attentional control. Our continued efforts are directed at examining this is

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