Industrial and Organizational Psychology
PERSPECTIVES ON SCIENCE AND PRACTICE

The Engine Is Important, but the Driver Is Essential: The Case for Executive Functioning

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We agree with Scherbaum, Goldstein, Yusko, Ryan, and Hanges (2012) that a return to a focus on intelligence and related constructs can greatly benefit the field of industrial and organizational (I–O) psychology. In fact, we suggest that one area in particular, executive functioning, may be especially promising. Scherbaum et al. addressed this concept only peripherally in their focal article, noting that the areas of clinical psychology, cognitive psychology, and neuropsychology have established measures aimed at ''assessing executive functions of the brain'' and that cognitive science has begun to view intelligence as consisting of planning, attention, simultaneous, and successive processes.

As a construct, executive functioning is centered in the frontal lobe of the brain, the area associated with the highest levels of mental functioning. Executive functioning monitors events, situational parameters, social ebbs and flows, and outcomes and makes strategic decisions such as when to initiate action, stop an action, or take a different approach (Banich, 2009). Similar to how a driver decides when and how to use an engine's horsepower, executive functioning acts as our own personal CEO, guiding and directing our basic information processing capabilities.

Theoretically, executive functioning can be differentiated into several distinct components. Perhaps the most common framework (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000) includes the three components set shifting (the ability to alternate between different tasks and demands), inhibition (the ability to self-regulate one's behavior to reduce impulsive actions and facilitate long-term goals), and updating (the ability to maintain information in short-term memory). An alternate structure includes a fourth component, dual tasking, which is the ability to *simultaneously* perform two separate tasks (Baddeley, 1996).

These executive functioning components appear to share some commonality, which is not surprising given that they are all prefrontal lobe functions. However, several lines of research provide evidence that they are separable. Miyake et al. (2000) used latent variable analysis to establish their distinctiveness and found that these components contribute differentially to performance on complex tasks. Similarly, functional magnetic resonance imaging research suggests that specific executive functions activate different prefrontal regions of the brain (e.g., Collette, Hogge, Salmon, & Van der Linden, 2006).

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Finally, neuropsychologists have observed that brain lesions that suppress one executive functioning component often leave the others intact (e.g., Baddeley, Della Sala, Papagno, & Spinnler, 1997).

The Relationship of Executive Functioning to General Mental Ability

A viable concern is whether executive functioning is simply a repackaging of general mental ability. Empirically, the correspondence between executive functioning and general mental ability in normal populations has only begun to be addressed. Using latent variable analysis, Friedman et al. (2006) found that although updating correlated highly, set shifting and inhibition correlated around .3 or less with measures of fluid and crystallized intelligence. Moreover, their results suggested that much of the association set shifting and inhibition have with fluid and crystallized intelligence is due to the variance they share with updating.

Theoretically, one has to wonder why set shifting and inhibition do not appear to correlate higher with general mental ability, particularly with fluid intelligence (the ability to solve novel problems such executive functioning measures). We offer three speculative yet reasonable hypotheses. First, executive functioning measures of set shifting and inhibition may in fact capture fluid or crystallized intelligence. Like most constructs, there are various narrow facets that underlie these two intelligence constructs, such as induction and reasoning being in the stratum below fluid intelligence (Carroll, 1993). Executive functioning measures may tap different narrow facets than measures of general mental ability. To illustrate, a common item on mental ability measures involves taking component figures (e.g., triangles) and mentally arranging them to see what overall figure they form. Because these and other types of items are typically presented one at a time, participants do not have to shift between different tasks nor do they have to self-regulate strategies to maximize long-term objectives.

Second, it is possible that executive functioning takes its place as yet another broad component in the stratum below general mental ability. Cattell and his colleagues (e.g., Horn & Cattell, 1966) identified nine such components (e.g., crystallized, fluid, and processing speed). None of these nine components include aspects of shifting back and forth between competing demands or inhibiting less favorable responses, at least not explicitly. Thus, one could consider executive functioning to be another broad component. Horn (1988) acknowledged that there most likely were additional components yet to be included.

Finally, it is possible that executive functioning should be placed *above* general mental ability in the intelligence stratum. As embodied in the automobile analogy presented earlier, it may be that executive functioning is best viewed as the component that directs the use of the skills and capabilities associated with general mental ability.

Common Measures of Executive Functioning

Executive functioning has its genesis in two fields: child development and neuropsychological assessment. One of the earliest known measures in child development is the Stroop test (Stroop, 1935), where words are written as one color (e.g., red) but displayed in a different color (e.g., green). Participants are instructed to report the color of the word as quickly as possible. Because processing of written information is dominant over processing of color, the Stroop test assesses ''directed attention,'' which is the ability to inhibit a dominant response and attend to a more secondary one. Another popular and more recent measure in this area is the go/no-go test (Nosek & Banaji, 2001), where participants display a given response when one stimulus (e.g., a square) is displayed but not when another stimulus (e.g., a circle) is displayed.

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In neuropsychology, executive functioning measures have been used to diagnose the nature and degree of functional impairment in cases such as traumatic brain injury and medical conditions (e.g., Alzheimer's). One of the earliest measures in this area is the Wisconsin Card Sorting Test (Berg, 1948), where participants sort cards based on one of three rules (shape, color, or number of items) that randomly change and require participants to adapt to these changes. This test is thought to be primarily a measure of set shifting (Miyake et al., 2000). Another common measure is the Tower of London (Shallice, 1982), a measure of inhibition, where participants must rearrange disks to match target patterns. What is interesting about the Tower of London is that some items require participants to first move a given disk *away* from its ending position, an operation with which ''linear thinkers'' tend to have more difficulty.

We close this section with several notes. First, these two areas are not entirely distinct, as some of the same measures are used in both development and neuropsychology. Second, there are a number of other executive functioning measures, which limited space prohibits us from covering. Third, considerable interest has emerged in recent years in applying executive functioning to normal adult populations, which could enhance applicability to I–O psychology. Finally, as is apparent, common existing measures of executive functioning were designed for use in areas very different from I–O psychology. One of the challenges will be to determine which measures are already suited for use in I–O psychology, which can be adopted for such use, and whether new measures need to be created.

Constructs and Measures of Executive Functioning in I–O Psychology

Of both theoretical and applied interest is the possibility that some measures and/or constructs already present in I–O psychology may overlap with executive functioning. For example, naval command-and-control simulators provide examples of measures that appear to assess set shifting. Mostly used in teamwork research, these tasks are similar to the Wisconsin Card Sorting Test in that they involve finding solutions to problems with unknown rules that change periodically. To be successful, a flexible adaptive strategy is required.

In a similar vein, exercises such as the in-basket (frequently used within assessment centers) could be seen as involving set shifting, due to the large number of issues to be handled, and inhibition because of the need to prioritize. Likewise, situational judgment tests involve asking applicants to respond to hypothetical work-related situations by choosing one of several possible, plausible options. The need to compare and analyze potential solutions simultaneously suggests that updating or dual tasking may be necessary to perform well.

The point here is that we may already be measuring executive functioning or similar constructs in some areas. By identifying them as such, we as a field can increase our understanding of what is actually being assessed. Furthermore, combining them into a single theory would allow us to build a nomological network to facilitate the generation of hypotheses and to make predictions that are more grounded in theory. We close by noting that no commonly accepted symbol has emerged for executive functioning. As such, we propose that e_F be used, at least within the I-O literature.

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