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Which tasks measure what? Reflections on executive function development and a commentary on Podjarny, Kamawar, and Andrews (2017)

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ABSTRACT

This article provides a selective review of the literature on executive function development and related topics, focusing on the conceptual and terminological confusions that might hinder communication among researchers in the field. The distinctions between working memory and updating, and between shifting and flexibility, are discussed. Methodological problems, which have implications regarding whether a certain task can be considered a measure of a psychological construct, are also discussed. Research on preschoolers is examined with particular attention because it is a rapidly growing but controversial field that seems in particular need of greater conceptual clarity. As a specific touchstone case, we discuss whether the Multidimensional Card Selection Task (MCST) created by Podjarny, Kamawar, and Andrews (2017) should better be considered a measure of concurrent cognitive flexibility or working memory capacity. It is argued that connecting tasks to theoretical constructs is not warranted unless based on rigorous empirical testing of well-formulated models.

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Introduction

At the turn of the millennium, Miyake et al. (2000) published an article that rapidly became very influential, proposing that the controversy on the unity or diversity of executive functions should be resolved by examining "relatively circumscribed, lower level functions," each tapped by "a number of well studied, relatively simple cognitive tasks" (p. 55), and comparing different models that posited either a unitary central executive or distinct correlated or uncorrelated functions. It is now widely cited that, analyzing individual differences in the adult population, Miyake et al. found evidence for three different but correlated functions that they labeled inhibition, shifting, and updating.

Just a few years later, Garon, Bryson, and Smith (2008) reviewed research on executive function in preschoolers, focusing on three functions that they labeled inhibition, shifting, and working memory. Diamond (2013) discussed executive function development, defining as core executive functions inhibition, working memory, and cognitive flexibility.

Controversial issues regarding the structure and development of executive functions

Executive functions and their development is a currently hot research field that is troubled by several controversies. Even in case we take Miyake et al.'s (2000) model as paradigmatic, we should not forget that these authors were quite open to future modifications in their model and made it very clear that they were not claiming the three executive functions they investigated to be the only ones existing and acknowledged that their study was leaving many issues open.

Executive function development: How many latent factors?

One major controversy deals with the differentiation of executive functions during the course of development. The finding of three distinguishable but correlated latent variables was replicated in research with older children (e.g., 8–13 years old: Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003). However, research with younger children usually yields a smaller number of factors. There is widespread agreement that executive functions are initially unitary or undistinguishable (e.g., Wiebe et al., 2011), but when and how they differentiate is still unclear. In particular, the structure of executive functions in preschoolers is widely debated, with some studies proposing a single factor for all executive functioning (e.g., Hughes, Ensor, Wilson, & Graham, 2010; Wiebe, Espy, & Charak, 2008) and other studies instead proposing a two-factor model (e.g., Miller, Giesbrecht, Müller, McInerney, & Kerns, 2012; Usai, Viterbori, Traverso, & De Franchis, 2014). Moreover, when two distinguishable factors seem to emerge, their precise nature is not always consistent across different studies (e.g., Lee, Bull, & Ho, 2013; Monette, Bigras, & Lafrenière, 2015).

The nature of inhibition

A second open question deals with the nature of inhibition. Some studies argued that inhibition might be better conceptualized as a set of functions rather than as a unitary construct. Dempster (1993) distinguished among controlling interference in the perceptual, linguistic, and motor domains; Harnishfeger (1995) distinguished among behavioral inhibition, cognitive inhibition, and interference; Nigg (2000) proposed even more fine-grained distinctions. Friedman and Miyake (2004) argued that all those distinctions are related to different stages of processing, namely ignoring irrelevant information during perceptual selection, inhibiting interfering information already present in working memory, and resisting prepotent responses while selecting appropriate ones. Friedman and Miyake also carried out an empirical test of this proposed distinction using an individual-difference design with adult participants, and they found that the measures hypothesized to index the perceptual and response stages actually loaded a single factor, which they called response and distractor inhibition. Resistance to proactive interference in memory instead was a separate and unrelated factor. However, they cautioned that this two-factor structure was found in a population of young healthy adults, and different results could be found in research with other populations or using a different set of measures.