Journal of Experimental Child Psychology xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Brief Report

The "EF" in deficiency: Examining the linkages between executive function and the utilization deficiency observed in preschoolers

Mary M. Stone [a,*], Fran C. Blumberg [b], Clancy Blair [c], Anthony A. Cancelli [b]

[a] School of Social and Behavioral Sciences, Marist College, Poughkeepsie, NY 12601, USA
[b] Graduate School of Education, Division of Educational and Psychological Services, Fordham University, New York, NY 10023, USA
[c] Department of Applied Psychology, Steinhardt School of Culture, Education, and Human Development, New York University, New York, NY 10003, USA

ARTICLE INFO

Article history:
Available online xxxx

Keywords:
Utilization deficiency
Strategy
Executive function
Preschool
Spatial memory
Attention
Cognitive development

ABSTRACT

We investigated the contribution of preschoolers' executive function (EF) skills to the effectiveness of their spontaneous strategy production when learning. Performance on computerized tasks of inhibition, attention shifting, and working memory was examined in relation to the effectiveness of 112 3- to 5-year-olds' spontaneous strategy production on a spatial memory task. Participants were asked to remember the locations of four toys representing one of two categories (animals or chairs) placed in a wooden box. Most participants spontaneously implemented a clustering strategy by removing and/or replacing the toys according to category membership. However, less than half of these strategic participants showed concomitant memory benefits (recall of toy locations). The remainder showed a utilization deficiency. After controlling for age and IQ, participants who performed better on EF tasks were more likely to benefit from having used the clustering strategy. These findings indicate that utilization deficiencies among preschoolers may be partially accounted for by individual differences in EF.

* Corresponding author.
E-mail address: mary.stone@marist.edu (M.M. Stone).

http://dx.doi.org/10.1016/j.jecp.2016.07.003
0022-0965/

Introduction

Developmental psychologists have long been interested in the cognitive processes underlying young children's learning strategies. Strategies refer to goal-directed behaviors (Siegler, 2007) that become available during the preschool years (Bjorklund, Dukes, & Brown, 2009). Specifically, preschoolers behave strategically when asked to recall the spatial arrangement of images (Miller & Weiss, 1981) and objects (Blumberg & Torenberg, 2003, 2005; DeLoache & Brown, 1983; Heisel & Ritter, 1981; Kannass, Plumert, McDermott, Moore, & Durich, 2004). Currently, little is known about the cognitive processes that facilitate these early memory strategies, although researchers speculate that executive function (EF) may be involved (e.g., Clerc, Miller, & Cosnefroy, 2014). EF is typically seen as composed of processes pertinent to working memory, inhibition, and attention shifting that underlie goal-directed behavior (see Best, Miller, & Jones, 2009). Although the relationship among these three processes has been characterized by both unity and diversity during adulthood (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000), their association appears to be more unified during the preschool years (Wiebe, Espy, & Charak, 2008).

The emergence of EF skills represents a cognitive milestone during early childhood (Carlson, Mandell, & Williams, 2004), a time when children begin using memory strategies. For instance, Kannass and colleagues (2004) examined the extent to which 3- to 5-year-olds used spatiotemporal strategies to enhance their recall of miniature object locations embedded in a model park scene with and without a visual path. Although the spontaneous reliance on the order of landmarks along the path generally facilitated recall accuracy for 4- and 5-year-olds, it negatively affected recall accuracy for 3-year-olds. Miller (1990) introduced the term *utilization deficiency* to describe such instances when children spontaneously implement a strategy that yields little or no benefit.

Utilization deficiencies have also been observed when preschoolers organize items to be remembered according to semantically meaningful categories (Carr & Schneider, 1991; Lange & Pierce, 1992), a strategy called categorical *clustering* (Bousfield, 1953). Blumberg and Torenberg (2003, 2005) found that most 3- and 4-year-old children spontaneously used categorical clustering when learning and recalling the spatial arrangement of one of two sets of miniature toys in a wooden box. However, only the performance of the 4-year-olds was consistently enhanced via the use of the clustering strategy. The 3-year-olds who used the same strategy demonstrated a utilization deficiency (Miller, 1990) whereby their clustering strategy use yielded lower recall than that of the 4-year-olds (Bjorklund et al., 2009).

Utilization deficiencies have been linked to age-related changes (e.g., Bjorklund, Coyle, & Gaultney, 1992; Miller & Weiss, 1981) and individual differences such as general intelligence (e.g., Bjorklund, Schneider, Cassel, & Ashley, 1994). Researchers have historically explained utilization deficiencies as reflecting limited resources whereby the spontaneous production of a strategy depletes the cognitive resources needed to benefit from it (e.g., Miller, Seier, Probert, & Aloise, 1991; Schneider, Kron, Hünnerkopf, & Krajewski, 2004; Woody-Dorning & Miller, 2001). However, the specific mental processes and resources used when children produce and use strategies are unclear. Recent theoretical links between utilization deficiencies and EF skills (Clerc et al., 2014) suggest that inhibition, attention shifting, and working memory may affect the availability of cognitive resources during strategy use. Specifically, children who present with utilization deficiencies on memory tasks may have sufficient EF skills to spontaneously implement a strategy but insufficient EF skills remaining to effectively use that strategy to enhance recall. Thus, utilization deficiencies could reflect poor functioning in any one or all three EF components.

Linkages between EF skills and strategy effectiveness in school-aged populations can be found in both the memory and academic literature. Studies with kindergarteners and first graders demonstrate that participants with larger working memory capacities successfully maintain the goal of memory tasks in mind and simultaneously implement strategies with no negative impact on recall (Schneider et al., 2004; Woody-Dorning & Miller, 2001). Schleepen and Jonkman (2012) also reported that working memory capacity may mediate the effectiveness of strategies implemented by 6- to 12-year-old children when completing memory tasks. Within the academic literature, working memory (e.g., Barrouillet, Mignon, & Thevenot, 2008), inhibition, and attention shifting abilities (e.g.,

Please cite this article in press as: Stone, M. M., et al. The "EF" in deficiency: Examining the linkages between executive function and the utilization deficiency observed in preschoolers. *Journal of Experimental Child Psychology* (2016), http://dx.doi.org/10.1016/j.jecp.2016.07.003