Journal of Experimental Child Psychology xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

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

Brief Report

Preschoolers' selective sustained attention and numeracy skills and knowledge

Alicia Brueggemann, Sara Gable *

Department of Nutrition and Exercise Physiology, College of Human Environmental Sciences, University of Missouri, Columbia, Columbia, MO 65211, USA

ARTICLE INFO

Article history:
Received 5 October 2017
Revised 12 February 2018
Available online xxxx

Keywords:
Executive functions
Selective sustained attention
Early numeracy
Preschool numeracy
Cardinality
Cardinal principle knowledge

ABSTRACT

This brief report addresses preschoolers' selective sustained attention (SSA) and early numeracy skills and knowledge. Past research indicates that children's attention and early numeracy are positively associated, yet some concerns have emerged about the age appropriateness of tools used to measure preschoolers' SSA. This study used a new measure—the Track-It Task—that demonstrates strong psychometric properties. In total, 31 at-risk preschoolers (M_{age} = 46.6 months) participated and were assessed on SSA, nonsymbolic quantity discrimination, and symbolic quantitative skills and knowledge. The ability to sustain attention in the face of distractions was positively correlated with preschoolers' verbal counting and one-to-one correspondence, Arabic numeral recognition, and cardinal principle knowledge. SSA was not significantly associated with child age or performance on a memory task. This study provides preliminary evidence that SSA may facilitate the process whereby young children become reliable counters and learn that the symbol system of numbers represents specific quantities.

Introduction

Executive functions (EFs) encompass a range of cognitive processes and behaviors and are central to early learning and adaptation (Griffin, Freund, McCardle, DelCarmen-Wiggins, & Haydon, 2016).

* Corresponding author.
E-mail address: gables@missouri.edu (S. Gable).

https://doi.org/10.1016/j.jecp.2018.02.001
0022-0965/

Current research centers on teasing apart EFs and identifying links with specific areas of learning. A promising line of inquiry centers on selective sustained attention (SSA) and children's early numeracy. During the preschool years, the ability to focus one's attention and ignore distractions facilitates learning how to count and map number symbols onto specific quantities (Geary, 2013; Geary & Moore, 2016). A lingering challenge, however, concerns the measurement of SSA during early childhood. The research presented here used a new measure of SSA—the Track-It Task (Fisher, Thiessen, Godwin, Kloos, & Dickerson, 2013)—to evaluate the relationship between attention and numeracy in a sample of at-risk preschoolers.

Background

Early number learning and counting skills develop concurrently with rapid growth in EF (Zelazo & Carlson, 2012). Positive relationships have been reported between measures of EF and children's mathematics abilities (e.g., Blair & Razza, 2007; Bull, Espy, & Wiebe, 2008; Clark, Pritchard, & Woodward, 2010). Even after accounting for domain-general measures of child intelligence, different aspects of EF (e.g., inhibitory control, set shifting, planning) predict young children's math skills (Clark et al., 2010; Espy, McDiarmid, Cwik, Meade Stalets, & Hamby, 2004; Steele, Karmiloff-Smith, Cornish, & Scerif, 2012). Conceptual models of EF vary and, for the most part, include working memory, mental flexibility, information processing, goal setting, inhibitory control, and SSA (Ackerman & Friedman-Krauss, 2017); a goal of the current study was to explore one particular aspect of EF, SSA (Steele et al., 2012), and its relationship with early numeracy.

An important milestone in preschoolers' numerical development is learning that the symbol system of numbers applies to specific quantities (Geary, 2013; Siegler & Lortie-Forgues, 2014). Acquiring this knowledge (i.e., cardinal principle knowledge) emerges from learning about counting (Le Corre, Van de Walle, Brannon, & Carey, 2006; Wynn, 1990). The ability to focus and shut out distractions and irrelevant input is essential to counting objects using one-to-one correspondence, reciting numbers in the exact same sequence, and knowing that the last number applied when counting a set of objects is the size of the set, all enduring principles of the symbol system of numbers (Gelman & Gallistel, 1978; Sarnecka & Carey, 2008). Furthermore, attentional control is associated with measures of math achievement independent of general intelligence (Clark et al., 2010; Duncan et al., 2007). Although the ability to focus on something and ignore distractions is associated with intelligence, attentional control and intelligence each make unique contributions to mathematical development (Geary, 2013) and there is some speculation that the balance between them in facilitating learning is different during the preschool years than during later stages (Geary & Moore, 2016). By evaluating the relationship between SSA and early numeracy in at-risk preschoolers, the current study will contribute to the knowledge base about linkages between specific features of EF and particular domains of academic learning.

The most commonly used measure of preschoolers' attentional capabilities is the Continuous Performance Test (CPT; Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956). The CPT was originally created to provide an assessment of sustained attention among individuals, both children and adults, who lived with or had suffered some form of brain damage. What made the CPT innovative was its requirement that research participants maintain a high level of sustained attention for a series of timed trials (i.e., 160 discrete trials in 10 min for adults, 80 discrete trials in 5 min for children). Participants were instructed to respond to particular stimuli (e.g., a certain letter) and to ignore nontarget stimuli (e.g., other letters). Although the CPT has been modified to improve its utility for evaluating children's attentional control (e.g., replacing letters with images of common objects), concerns remain that the tool does not adequately engage young children's developing attentional capabilities (Fisher & Kloos, 2016; Fisher et al., 2013). In particular, on adapted versions of the CPT, a notable portion of participants younger than 4.5 years (approximately 50%) do not meet the required performance criteria.

The Track-It Task

The current study used a new measure of child SSA—the Track-It Task—that improves on the shortcomings of the CPT described above (Fisher & Kloos, 2016; Fisher et al., 2013). Its design and imple-

Please cite this article in press as: Brueggemann, A., & Gable, S. Preschoolers' selective sustained attention and numeracy skills and knowledge. *Journal of Experimental Child Psychology* (2018), https://doi.org/10.1016/j.jecp.2018.02.001