One or two years of participation: Is dosage of an enhanced publicly funded preschool program associated with the academic and executive function skills of low-income children in early elementary school?

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A R T I C L E   I N F O

Article history:
Received 12 April 2016
Received in revised form 24 February 2017
Accepted 10 March 2017

Keywords:
Preschool dosage
Longitudinal academic outcomes
Executive function

A B S T R A C T

This study extends previous work conducted with a sample of primarily low-income children attending an enhanced, publicly funded preschool program and assesses the effect of preschool dosage (i.e., receiving one or two years of preschool) on children's academic and executive function (EF) outcomes at first and second grade. Because random assignment of children to receive one or two years of preschool was not possible, we used propensity score one-to-one matching to create two groups of equal size—a one-year group (i.e., those who attended preschool for one year and represented low preschool dosage, N = 144) and a two-year group (i.e., those who attended preschool for two years and represented high preschool dosage, N = 144) to control for potential selection bias. With respect to academic skills, children in the two-year group had higher scores on receptive vocabulary (as assessed by the Peabody Picture Vocabulary Test, Third Edition) and math skills (as assessed by the Applied Problems subtest of the Woodcock-Johnson Psychoeducational Test Battery-Revised [WJ-R]). They also had higher Broad Reading composite scores on the WJ-R at second grade. With respect to EF skills, at both first and second grade, children in the two-year group had higher scores on a working memory task (Backward Digit Span); they also made fewer perseverative errors and completed more categories on a task assessing set-shifting (Wisconsin Card Sort Task-64). Finally, children in the two-year group were better adjusted in school (i.e., they were less likely to have been retained or have received special education services by second grade). Effect sizes ranged from 0.22 to 0.40, suggesting that providing low-income children with an extra year of high-quality preschool continues to benefit students into elementary school. We discuss implications of the findings for public policy.

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1. Introduction

A feature of preschool education that is gaining attention in the field, and that was recently the topic of investigation in a large secondary data analysis of several federal data sets, is preschool dosage (Burchinal, Zaslow, & Tarullo, 2016). Preschool dosage has been defined in several different ways in the research, reflecting frequency (e.g., number of days attended), amount of time (e.g., hours attended per day), or length of participation (i.e., years of exposure). Although most children who enter public preschool do so at age four and attend for one year, early intervention models (e.g., Head Start) have often enrolled both three- and four-year-old children, and there has been a shift over time toward more children entering these programs earlier. For example, the number of three-year-olds enrolled in Head Start increased from 24% in 1980 to 40% in 2007 (Aikens, Kopack Klein, Tarullo, & West, 2013).

There are challenges to understanding the meaning of preschool dosage when it is measured in terms of years of exposure because this indicator is often confounded with age of entry. That is, children

http://dx.doi.org/10.1016/j.ecresq.2017.03.004
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who attend preschool for two years (high dosage) enter programs at age three and those who attend preschool for one year (low dosage) enter at age four, making it impossible to determine whether the benefits of longer exposure are due to the dosage level or that children’s exposure began at a younger age.

The current study drew from the evaluation of a publicly funded preschool program1 that served low-income children. The program followed Head Start guidelines and used High/Scope (Schweinhart & Weikart, 1997) as its base curriculum but was enhanced with the Preschool Promoting Alternative Thinking Strategies (Preschool PATHS; Domitrovich, Greenberg, Kusche, & Cortes, 2005) curriculum and instructional strategies designed to promote children's literacy. The program enrolled both three- and four-year-old children, which provided the opportunity to examine how preschool dosage, defined as years of program participation, affected children's outcomes. Prior evaluation studies of this program documented the benefits of attending for two years compared to one year on children's academic (Domitrovich et al., 2013) and social-emotional (Moore et al., 2015) functioning at kindergarten. The current study extends this previous work by examining the effects of dosage on children's academic performance and executive function (EF) skills at first and second grade.

1.1. Effect of preschool on academic performance

The strongest evidence that preschool programs can improve low-income children's outcomes comes from evaluations of 'model' preschool programs such as the Perry Preschool Program and the Abecedarian project. These interventions, which targeted low-income children, found effects on children's intelligence scores, school achievement, mental health outcomes, juvenile delinquency and crime, as well as adult earnings (e.g., Campbell & Ramey, 1994; Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; Schweinhart, 2001; Schweinhart, Barnes, & Weikhart, 1993). Moreover, cost-benefit analyses reveal a high return of investment on every dollar invested in these programs (e.g., Barnett & Masse, 2007; Schweinhart, 2001).

While findings from these early intervention studies are impressive, these programs are more expensive and had larger and better-trained staff as compared to most current public preschool programs. Further, most of these studies took place in the 1960s and 1970s and had control groups that received little or no enrichment outside the home, as these experiences were less prevalent at that time. In the past decade, several large-scale evaluations of state-funded public preschool programs (such as the universal preschool programs offered in Oklahoma and Virginia) have reported effects on reading and math achievement at school entry and reductions in grade retention at kindergarten (Gormley, Gayer, Phillips, & Dawson, 2005; Huang, Invernizzi, & Drake, 2002). Early childhood experts note, however, that no current public preschool program has achieved results comparable to the original 'model' programs (Barnett, 2010). One reason for this may be that preschool is now being compared to a wider range of services.

The nation's largest program for low-income children, Head Start, has documented similarly modest benefits on school readiness outcomes (e.g., Garces, Thomas, & Currie, 2002; McKey et al., 1985; Pigott & Israel, 2005). The longitudinal impact of Head Start in terms of children's academic or social-emotional outcomes is less clear. The Head Start Impact study (Puma et al., 2010), which was a large-scale randomized controlled trial, reported small effect sizes on reading, pre-writing, vocabulary, and parent-reported reading skills at kindergarten for children who entered Head Start at age three or age four. Although most of these effects disappeared by the end of first grade, that there were several challenges to determining the study's longitudinal impacts. For example, nearly half of the three-year-olds in the control group enrolled in Head Start during their second year. The authors attempted to control for these "crossovers" in the control group and for children in the intervention group who did not eventually enroll in Head Start by using the treatment-of-the-treated approach (i.e., considering all children who enrolled in Head Start as part of the intervention group and all children who did not enroll in Head Start as part of the control group, regardless of initial random assignment status). However, although using this approach resulted in stronger effect sizes in kindergarten, it did not change the overall pattern or statistical significance of the findings. The study thus did not find effects of Head Start participation on children's longitudinal outcomes. Another issue is that even in the first year of the study, children in the control group were permitted to enroll in non-Head Start programs or other forms of non-parental care. This was challenging in terms of studying impacts, especially with an increase in the prevalence of state-funded preschool programs and other child care options that children in the control group likely had access to. Hence, the results reported by the Head Start Impact study are likely an underestimate of the effects of the Head Start program.

1.2. Effects of preschool on executive function skills

The strongest effects of preschool education are generally on cognitive outcomes (Camilli, Vargas, Ryan, & Barnett, 2010; Gorey, 2001; Puma et al., 2010). Although much of the research examining program impacts has focused on academic outcomes, there has been growing interest in documenting the effects on children’s EF skills, which comprise the distinct but interrelated abilities of inhibitory control, working memory, and set-shifting (e.g., Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003; Miyake et al., 2000). Inhibitory control refers to children's ability to suppress a prepotent response in favor of a task-relevant response. Working memory refers to the ability to hold and manipulate information when engaging in problem solving. Finally, set-shifting refers to children's ability to forfeit an old, irrelevant strategy in favor of a new, relevant one when solving a problem.

Children from low socioeconomic backgrounds are at risk for poor EF development because the physical and environmental risks associated with poverty have negative effects on brain development (Shonkoff et al., 2012). For instance, research suggests that adversity in the environment alters the physiology of the stress response, which in turn affects EF abilities (Arnsten & Li, 2005; Blair et al., 2011). There is also some evidence to suggest that language abilities contribute to the association between EF and socioeconomic status (Noble, McCandliss, & Farah, 2007; Noble, Norman, & Farah, 2005; Rhee, Greenberg, Lanza, & Blair, 2011), which is not surprising given the regulatory function that emotion-related language serves (Eisenberg, Sadosky, & Spinrad, 2005). Longitudinal research suggests that more advanced EF skills build upon skills that are established in early childhood (Garon, Bryson, & Smith, 2008) and develop as a result of interactions between individuals and their environment (Bernstein & Waber, 2007).

Research indicates that individual differences in EF skills are meaningful and predictive of children's academic (e.g., Bull & Scerif, 2001; Bull, Espy, & Wiebe, 2008; Gathercole, Pickering, Knight, & Stegmann, 2004) and social-emotional skills (e.g., Nigg, Quamra, Greenberg, & Kusché, 1999; Rhee, Greenberg, & Domitrovich, 2009; Riggs, Blair, & Greenberg, 2004). Moreover, intervention research suggests EF skills are malleable and that

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1 We refer to the program in this study as a “publicly funded preschool program.” As we describe in the Methods section, the program was offered only to families who met eligibility for Head Start in the first year. In the second year, the district expanded the program using non-federal dollars and offered it to all families in the district.
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