



Research Paper

Dual language learning, inhibitory control, and math achievement in Head Start and kindergarten

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ABSTRACT

This study examined whether developmental patterns of inhibitory control (IC) and kindergarten math achievement differed among Head Start children with varying dual language learning status. This study further explored the potential mediation effects of IC development as an explanation of differences in kindergarten math skills across children with varying dual language learning status. Based on their English skills and home language use, children' dual language learning status was categorized into (1) Spanish-English bilingual children, (2) Spanish-English dual language learners with limited English skills (DLLs-LES), and (3) English-monolingual children. Analyses were conducted using data from the Head Start Family and Child Experiences Survey (FACES) 2009 Cohort. Results showed that bilingual children presented greater IC at Head Start entry than DLLs-LES and faster growth in IC through kindergarten (1.5 years) than English-monolingual children. Bilingual children also outperformed monolingual children and DLLs-LES in math at kindergarten, despite the fact that they had lower baseline math skills than monolingual children. DLLs-LES, on average, presented the lowest IC skills and math skills through kindergarten. DLLs-LES, however, presented faster growth in IC than English-monolingual children through kindergarten. The achievement gaps in math among the three groups were explained by relative differences in IC development among the groups. The current study with low-income preschoolers supported emerging literature suggesting the benefits of bilingualism for cognitive skills and learning. Study implications are discussed.

1. Introduction

The U.S. education system includes a significant proportion of dual language learners (DLLs) who are simultaneously developing language skills in English and their home language or who are developing their home language while learning English as a second language (Office of Head Start, 2008). The term “DLL” encompasses a broad population of individuals who have varying degrees of skill in their home language and the English language. The term is often used interchangeably with “limited English proficient (LEP),” “English language learners (ELL),” “English learners,” and “children who speak a language other than English” (Office of Head Start, 2008).

1.1. Dual language learners in Head Start

In Head Start, a federally funded comprehensive educational program serving low-income preschoolers and their families, more than 25% of children use languages other than English in their home, with 92% of those children speaking Spanish (Moiduddin, Aikens, Tarullo,

West, & Xue, 2012). DLLs are present in more than 70% of Head Start classrooms (Hulsey et al., 2011), and more Spanish-speaking children attend Head Start than any other type of public or private preschool (Figueras-Daniel & Barnett, 2013). Acknowledging the linguistic diversity in its program, Head Start has emphasized providing services to children and their families that are sensitive to their cultural and linguistic heritage. The Head Start Act of 1998 and the Head Start Program Performance Standards mandate that Head Start teachers and staff support DLLs' learning in both English and their home language and provide culturally appropriate and respectful services to families in the program (Office of Head Start, 2008). Head Start's efforts to support the DLL population are reflected in DLLs' experiences in the program. According to data obtained from Head Start parents, approximately 60% of DLLs in Head Start received instruction in their home language in the program, and 85% were in a Head Start program where staff members could speak the DLLs' home language (Administration for Children and Families, 2013).

Research demonstrates that Head Start has a positive impact on DLLs' development. According to the Head Start Impact Study, a

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nationally representative randomized control study on the impact of Head Start (Administration for Children and Families, 2010), DLLs in Head Start achieved higher skills in various developmental domains (e.g., cognitive and social-emotional skills) at the end of kindergarten than non-Head Start DLLs, who could enroll in other types of early childhood programs and services based on their parents' decision. Nonetheless, other observational research found that DLLs in Head Start presented lower academic skills at program exit than did their monolingual peers in the program, mainly due to their lower academic skills at program entry (Administration for Children and Families, 2013).

1.2. Perspective on dual language learners

Some scholars believe that the cognitive load imposed by learning more than one language may hamper DLLs' early development and learning (see Hakuta, 1986). Others consider the use of a home language other than English to be a family risk indicator along with a single-parent household, income below the federal poverty level, and mothers' having less than a high school education (Rathbun & West, 2004). Researchers have also acknowledged that in the U.S., DLL status can be a source of psychological distress (Smith-Adcock, Daniels, Lee, Villalba, & Indelicato, 2006) and a predictor of lower academic and language skills (Páez, Tabors, & López, 2007), especially when DLLs have limited English proficiency.

More recent views in literature, however, refute such a solo focus on the disadvantageous effects of dual language learning on early development. Although delays in acquiring some aspects of language, such as vocabulary, have been found among DLLs (Bialystok, Craik, Green, & Gollan, 2009), extensive recent research has suggested cognitive advantages of learning two languages, particularly in the area of executive function (Bialystok, 2001, 2005, 2015; Bialystok et al., 2009; Bialystok & Shapero, 2005; Bialystok & Viswanathan, 2009; Carlson & Meltzoff, 2008; Engel de Abreu, Cruz-Santos, Tourinho, Martin, & Bialystok, 2012; Garbin et al., 2010).

1.3. Bilingual benefits for executive function

Executive function is a "higher order, more effortful or deliberative [aspect] of self-regulation" (Blair & Ursache, 2011, p. 300). A central domain of executive function is inhibitory control (IC), which is related to the ability to pay attention and control natural but unnecessary thoughts and behaviors (McClelland, Cameron, Wanless, & Murray, 2007). As is true in other domains of executive functioning, IC is often found to be higher among bilinguals—those DLLs who have extensive experience using two languages. For example, Carlson and Meltzoff's (2008) study of kindergarteners, using nine different measures of executive functioning, found comparable scores in executive functioning tasks between Spanish-English bilinguals and English monolinguals, despite the fact that the bilingual children had lower family socioeconomic status (SES). When children's verbal skills, parental education, and child age were controlled in Carlson and Meltzoff's study, the lower SES Spanish-English bilingual children performed significantly better in overall executive function tasks compared to their middle SES English monolingual counterparts, especially for those tasks requiring children to manage conflicting attention (IC and working memory). Bialystok and Shapero's (2005) study of 6-year-olds further showed that bilinguals presented fewer errors in IC tasks compared to English monolinguals. In one of the measures the authors used to capture IC skills, called the Opposite Worlds Tasks, children were provided a picture board and instructed to name the farm animals that they saw along the pictured road as quickly as they could. In this task, children were first instructed to correctly identify the animal and then instructed to name a different animal previously specified as the pictured animal's opposite, requiring children to inhibit responses and manage conflicting information.

Previously, Bialystok (2001) argued that bilinguals' higher skills in

inhibition constitute one of the most consistent findings of bilingual benefits in empirical studies, along with skills relating to selective attention. It is speculated that bilingualism—the ability to function in two languages when needed (Grosjean, 1989)—may have "the salutary effect of boosting control processes in nonverbal domains because those same general processes are required to manage two-language systems" (Bialystok et al., 2005, p. 30). It is believed that when bilinguals use one of their languages, both languages are cognitively active (Guttenag, Haith, Goodman, & Hauch 1984; Kroll, Bobb, & Hoshino, 2014), and thus bilinguals frequently practice maintaining attention to the context-appropriate language while inhibiting the other language in their daily linguistic contexts. These control processes to manage two languages were thought to improve other aspects of cognitive processing as well (Bialystok et al., 2009).

Emerging studies on bilingualism and IC have shifted views on early DLLs from a developmentally at-risk population to early learners who have cognitive strengths that can assist their development. Given the benefits of bilingualism for IC (Bialystok, 2001), some scholars have further argued that the academic delays often observed in DLLs are temporary and thus of little concern (Li, 2003). Indeed, Bialystok's (2001) book, *Bilingualism in Development: Language, Literacy and Cognition*, discussed the effects of bilingualism on nonlinguistic aspects of children's cognition, such as quantity, number, problem-solving, and sorting, all skills that are linked to overall math achievement. Bialystok noted that the advantage of bilingualism is evident when cognitive tasks require high levels of inhibition or moderate levels of conceptual demands or include misleading information (e.g., a task that involves comparing the number of blocks in a tall tower made with relatively few blocks and a short tower made with a greater number of blocks).

Halle, Hair, Wandner, McNamara, and Chien's (2012) empirical research on a nationally representative sample of first-time kindergartners further supports the potential benefits of being bilingual for learning. Their study showed that DLLs who acquired English proficiency by kindergarten entry were either keeping up with or outperforming native English-speaking children in math and reading through eighth grade, controlling for comprehensive child, family, classroom, and school-level covariates. The authors, however, found somewhat poorer learning trajectories for DLLs who obtained English proficiency later than kindergarten (i.e., children who acquired English proficiency by the spring of first grade, and children who did not acquire English proficiency by the spring of first grade). These findings indicate that bilingual advantages in academic achievement are possibly limited to early bilinguals and/or children with a longer duration of bilingual experience. The possible mechanisms explaining such group differences, however, were not discussed in Halle and colleagues' paper.

1.4. Executive function and math

Much literature has shown that executive functioning is a foundational skill for early academic achievement, particularly in math (Allan, Hume, Allan, Farrington, & Lonigan, 2014; Blair & Diamond, 2008; Blair & Razza, 2007; Espy et al., 2004; Lonigan, Allan, Goodrich, Farrington, & Phillips, 2015; McClelland, Cameron, Connor et al., 2007; McClelland, Cameron, Wanless et al., 2007). For example, Blair and Razza's (2007) study with preschool-aged children in Head Start showed that IC skills were a significant predictor for math, phonemic awareness, and letter knowledge, with a higher effect size for math than literacy-related outcomes. In Blair and Razza's study, IC was found to be the only significant predictor for the three kindergarten academic outcomes among other executive function/self-regulation skills (e.g., attention-shifting and effortful control). Similar results were found in a recent meta-analysis of 75 peer-reviewed studies of preschool and kindergarten children from households of varying SES (Allan et al., 2014). Allan and colleagues' meta-analysis, which included Blair and Razza's study in their examination, found that IC skills were moderately

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