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Cognitive control and phonological awareness in the acquisition of second language vocabulary within the Spanish-English dual immersion context

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ABSTRACT

Studies that have examined the role of cognitive control in the acquisition of second language vocabulary in dual language learners are rare. First and second language vocabulary, phonological awareness and cognitive control were assessed in Spanish-English dual language learners (kindergarten-4th grade; half native-English and half native-Spanish) from a Spanish-English immersion program in the US. Children included were from monolingual homes and acquired their second language in school. Children's first language vocabulary was strongly and negatively correlated with their second language vocabulary. Although performance on the cognitive control task was positively associated with first language receptive vocabulary and phonological awareness, it was children's sound segmenting skills (i.e. elision) that uniquely predicted both their first and second language vocabulary scores. In addition, mediation regression analyses revealed that the relation between first and second language vocabulary was mediated by phonological awareness. Overall our findings highlight the importance of sound segmenting skills in second language vocabulary acquisition.

An essential aspect of higher order cognition is the person's ability to control their thoughts to achieve goals. This capacity is known as cognitive control (Bunge, Dudukovic, Thomason, Vaidya, & Gabrieli, 2002). Empirical evidence indicates that cognitive control develops slowly over time in tandem with a maturing pre-frontal cortex (Diamond, 2013). Developing cognitive control provides one with the capacity to shift flexibly between two or more conflicting representations (Cragg & Nation, 2010). To be able to accomplish cognitive flexibility the individual must achieve two competencies - suppression of interference and response inhibition (Bunge et al., 2002). Suppression of interference refers to the ability to filter out information that is irrelevant to the ongoing task whereas response inhibition harkens to the ability to inhibit a prepotent, but inappropriate, response to the task at hand (Bunge et al., 2002; Cragg & Nation, 2010). Past research has demonstrated that cognitive control is related to school readiness and academic achievement in school children (Blair & Razza, 2007; Espy, Bull, Martin, & Stroup, 2006; McClelland, Cameron, Connor et al., 2007). Despite the considerable level of interest in the ontogeny of cognitive control (Anderson, 2002), research with children has lagged in comparison to studies with adults (Lan, Legare, Ponitz, Li, & Morrison, 2010).

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1. Vocabulary and cognitivecontrol

According to Vygotsky (1962) children use language as a tool to guide and monitor their goal-oriented behavior. Consequently, some developmental researchers have proposed that vocabulary and cognitive control may be interrelated in monolingual children, however the exact dimensions of this relationship remain unclear (Cragg & Nation, 2010; Fedorenko, 2014; Singer & Bashir, 1999). Within this line of research, researchers have claimed that vocabulary development supports cognitive control through children's use of self-directed speech (Cragg & Nation, 2010; Marcovitch & Zelazo, 2009). Self-directed speech (i.e. essentially children talking to themselves) allows children to maintain rules in working memory that help them deploy cognitive resources appropriately for goal-directed activities (Zelazo, 2006). An example of self-directed speech could be a child thinking to himself/herself during dinner: *If I eat broccoli mom will give me dessert after*. Empirical evidence indicates that children's use of spontaneous private speech is predictive of their performance in cognitive control tasks (Carlson & Beck, 2009).

Still others have speculated that it is not vocabulary development per se, but the use of a verbal label that allows children to allocate attentional resources effectively (Homer & Nelson, 2009; Kirkham, Cruess, & Diamond, 2003). With an expanding vocabulary and semantic knowledge base, children can exploit their ability to use verbal labels to hold dual representations in mind (Homer & Nelson, 2009). With the assistance of a verbal label children can simultaneously maintain two mental representations in their mind (Miller & Marcovitch, 2011). Thus, the verbal label allows children to maintain the actual word and the mental representation of the word in their mind. For instance, Kirkham et al. (2003) have shown that the use of verbal labels allowed 3 year olds to succeed on a task that they would have normally failed. By actively encouraging the children to use verbal labels for objects (e.g. "What is this?") and their relationship (e.g. "Where does this go?") in their task, they were able to demonstrate that the act of labeling helped the children acquire more abstract and complex representations. This, in turn, allowed the children to refocus their attention to the more germane aspects of the task (Kirkham et al., 2003).

This truncated review of the literature of literature suggests that children's vocabulary development may be implicated in the development of cognitive control (McClelland, Cameron, Wanless et al., 2007). However, the role of cognitive control in vocabulary development (in the first or second language) of bilingual children remains largely unexplored (Nicolay & Poncelet, 2013).

2. Vocabulary and cognitive control in dual language learners

In order to successfully acquire a second language (hereafter, L2), children must learn multiple subsystems of the language including phonology, morphology, grammar, pragmatics and vocabulary (Barcroft, 2004; Espy, 2004). Although the development of L2 grammar has been extensively studied (Hoff et al., 2012), some have highlighted the importance of L2 vocabulary learning (Barcroft, 2004; Elgort, 2011) in second language acquisition. Ellis (1994) has argued that vocabulary learning is dependent on a combination of unconscious processes (outside of individual's attentional control) and conscious processes (that engage attentional control). Once considered difficult (see Hakuta, 1986 for historical overview), empirical evidence indicates that when exposed to two languages children are able to acquire two vocabularies (Hoff, 2003, Hoff et al., 2012; Kovács & Mehler, 2009). But, there is great variability in the ultimate level of attainment of bilinguals' L2 vocabulary (Hoff, 2003; Hoff et al., 2012). Various proposals have attempted to account for this unpredictability including, brain maturation (Johnson & Newport, 1991), interference from first language (Bialystok, 2015), and psychosocial factors associated with language exposure and experience (Hoff et al., 2012).

A substantial majority of the studies that have examined second language vocabulary acquisition in bilingual children have focused on children who learn two languages simultaneously from birth (Bialystok & Barac, 2012; Kan & Kohnert, 2005). Yet, many children in the U.S. are sequential bilinguals who learn one language at home and are exposed to their L2 in school (Gross, Buac, & Kaushanskaya, 2014; Kan & Kohnert, 2005; Kan, 2014). As Hammer, Lawrence and Miccio (2008) have shown, language exposure both at home and school has an impact on vocabulary development in bilingual children. Even after two years of exposure to English in Head Start, children who were exposed to *both* Spanish and English at home had larger English vocabularies than children from monolingual Spanish homes; who exhibited larger Spanish vocabularies. In contrast, Kan and Kohnert (2005) reported that vocabulary growth in L2 (i.e. English) outpaced L1 (i.e. Hmong) in bilingual preschoolers who were only exposed to Hmong (a language native to Vietnam and China) at home and predominantly English in school. Thus, language exposure at home and at school influence vocabulary development in bilingual children; but the influence of language exposure in an informal setting (i.e. home) versus a formal setting (i.e. school) remains unclear.

We are defining dual language learners (hereafter, DLLs) as children who are learning two languages simultaneously or those who are still acquiring their first language as they learn their second language (Gutiérrez, Zepeda, & Castro, 2010; Hammer et al., 2014). Intriguingly DLLs often present with lower vocabulary scores in comparison to their monolingual peers (Hammer, Jia, & Uchikoshi, 2011, 2014; Páez, Tabors, & López, 2007), yet there is some evidence that they exhibit benefits in cognitive control (Barac & Bilalystok, 2012; Carlson & Meltzoff, 2008, however see Anton et al., 2014; Duñabeitia et al., 2014 for notable examples of the failure to replicate this effect). In a recent study, Kalia, Daneri, and Wilbourn, (2017) compared English monolingual children to Spanish-English DLLs on vocabulary and executive functions. Despite exhibiting smaller English vocabularies, the DLL children outperformed their monolingual peers on two measures of executive function (i.e. Dimensional Change Card Sort; Zelazo, 2006; Lexical Stroop Sort; Wilbourn, Kurtz, & Kalia, 2012). Furthermore, Kalia et al. (2017) showed that DLLs' two vocabularies were differentially associated with their executive functions. Whereas English vocabulary was positively correlated with executive processes, their Spanish vocabulary was *negatively* correlated with performance on the two executive function measures. The observed differential relations between cognitive control and Spanish and English vocabulary in Spanish-English DLLs highlights the fact that the developmental processes that underlie first (L1) versus second (L2) language vocabulary acquisition may be an important variable to consider in our