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Attentional control in early and later bilingual children

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ABSTRACT

We examined differences in attentional control among school-age children who were monolingual English speakers, early Spanish-English bilinguals (who began speaking both languages by age 3), and later Spanish-English bilingual children (who began speaking English after age 3). Children's attentional control was tested using the Attention Network Test (ANT). All language groups performed equally on ANT networks; however, when controlling for age and verbal ability, groups differed significantly on reaction time. Early bilingual children responded faster on the ANT compared to both monolingual and later bilingual children, suggesting an attentional monitoring advantage for early bilinguals. These results add to evidence of advantaged cognitive functioning among bilinguals and are consistent with the possibility that children who begin speaking a second language earlier in childhood have greater advantages, due either to effects of acquiring a second language earlier or to longer duration of bilingual experience.

1. Introduction

A growing body of research suggests that bilingual individuals outperform monolinguals on a variety of cognitive measures (Bialystok, 1999; Bialystok, Craik, & Ruocco, 2006; Bialystok, Craik, & Ryan, 2006; Carlson & Meltzoff, 2008; Costa, Hernandez, & Sebastian-Gallès, 2008). These advantages,

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which have been characterized as advantages in cognitive control, have been documented across the lifespan. Improved cognitive control among bilinguals has been observed in bilingual-exposed infants (Kovàcs & Mehler, 2009a, 2009b), toddlers (Poulin-Dubois, Blaye, Coutya, & Bialystok, 2011) bilingual preschool children (Bialystok, 1999; Bialystok & Martin, 2004; Carlson & Meltzoff, 2008; Yoshida, Tran, Benitez, & Kuwabara, 2011), young adults (Costa, Hernàndez, Costa-Faidella, & Sebastiàn-Gallès, 2009; Costa et al., 2008; Prior & MacWhinney, 2010) and older adults (Bialystok, Craik, & Freedman, 2007; Bialystok, Craik, Klein, & Viswanathan, 2004). Further, cognitive control advantages of bilingualism have been demonstrated using multiple cognitive tasks and have been found among bilinguals speaking a variety of language pairs, suggesting that these effects are not limited to a single task or particular language pairing (see Adesope, Lavin, Thompson, & Ungerleider, 2010, for recent meta-analysis).

1.1. Bilingualism and cognitive control

Although bilinguals have outperformed monolinguals in a variety of cognitive skills, two types of cognitive control skills have been consistently reported to be advantaged among bilinguals: *attentional inhibition* and *attentional monitoring*. Attentional inhibition is the ability to ignore distracting or conflicting information in order to focus attention on relevant information. Tasks that measure attentional inhibition commonly include distracting information that participants must ignore in order to respond successfully. For example, in classic flanker tasks the use of attentional inhibition is necessary on incongruent trials in which the target arrow is oriented in the opposite direction of flanker arrows (→ → ← → →). On such incongruent trials, successful responding requires participants to ignore the flankers to focus only on the target arrow. Attentional inhibition is not required on congruent trials in which all flankers are oriented in the same direction (→ → → → →), as there is no conflicting information to ignore. Typically, responses on congruent trials are faster and more accurate than responses on incongruent trials. The difference in reaction time or accuracy between congruent and incongruent trials provides an index of participants' attentional inhibition abilities, with smaller differences between congruent and incongruent trials representing more efficient attentional inhibition, or in other words, less cost of ignoring conflicting information.

Bilingual adults and children have been previously reported to show smaller differences between congruent and incongruent trials (i.e., more efficient attentional inhibition) in flanker tasks (Costa et al., 2008, 2009; Luk, De Sa, & Bialystok, 2011; Toa, Marzecovà, Taft, Asanowicz, & Wodniecka, 2011; Yang & Lust, 2004; Yoshida et al., 2011), the Simon task (Bialystok, Craik, et al., 2005; Bialystok et al., 2004; Bialystok, Martin, & Viswanathan, 2005), and antisaccade tasks (Bialystok, Craik, & Ruocco, 2006; Bialystok, Craik, & Ryan, 2006; Bialystok & Viswanathan, 2009). Such bilingual advantages in attentional inhibition are frequently explained as resulting from the need for bilinguals to keep their two language systems separate. In order to maintain this separation, it is hypothesized that bilinguals must employ attentional inhibition to avoid accessing the non-target language and instead access the target language (Green, 1998). However, recent evidence from bilingual-exposed infants who demonstrate cognitive advantages (Kovàcs & Mehler, 2009a) suggests that lexical access alone cannot account for these advantages, as pre-verbal infants demonstrate bilingual advantages over monolingual peers. The source of bilingual advantages in attentional inhibition thus remains under debate, but available evidence suggests that both exposure to and production of two languages may underlie these cognitive advantages.

The second advantaged skill, attentional monitoring, refers to the ability to attend and respond to changing task demands. For example, in the previously described flanker task, congruent and incongruent trials are intermixed, resulting in the need for participants to switch back and forth between responding to incongruent trials that require attentional inhibition and responding to congruent trials requiring no attentional inhibition. Attentional monitoring is indexed by the overall reaction time to both congruent and incongruent trials, with a faster reaction time indicating better attentional monitoring (i.e., less cost of switching between responses).

Based on average reaction time, bilinguals have outperformed monolinguals on attentional monitoring measures including flanker tasks (Costa et al., 2008, 2009; Toa et al., 2011; Yang & Lust, 2004), the Simon task (Bialystok, Craik, et al., 2005; Bialystok, Martin, et al., 2005; Martin-Rhee & Bialystok, 2008), dual dimension classification tasks (Barac & Bialystok, 2012) and antisaccade tasks (Bialystok,