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The effect of childhood bilectalism and multilingualism on executive control

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ABSTRACT

Several investigations report a positive effect of childhood bilingualism on executive control (EC). An issue that has remained largely unexamined is the role of the typological distance between the languages spoken by bilinguals. In the present study we focus on children who grow up with Cypriot Greek and Standard Modern Greek, two closely related varieties that differ from each other on all levels of language analysis (vocabulary, pronunciation, grammar). We compare the EC performance of such bilectal children to that of English–Greek multilingual children in Cyprus and Standard Modern Greek-speaking monolingual children in Greece. A principal component analysis on six indicators of EC revealed two distinct factors, which we interpreted as representing working memory and inhibition. Multilingual and bilectal children exhibited an advantage over monolinguals that was evident across EC factors and emerged only after statistically controlling for their lower language proficiency. These results demonstrate that similar EC advantages as previously reported for 'true' bilingual speakers can be found in bilectal children, which suggests that minimal typological distance between the varieties spoken by a child suffices to give rise to advantages in EC. They further indicate that the effect of speaking more than one language or dialect on EC performance is located across the EC system without a particular component being selectively affected. This has implications for models of the locus of the bilingual advantage in EC performance. Finally, they show that the emergence of EC advantages in bilinguals is moderated by the level of their language proficiency.

1. Background

1.1. Introduction

A growing body of research has recently focused on the relation between bilingualism and the development of specific cognitive systems, particularly language and executive control (henceforth, EC) (see, among others, Adesope, Lavin, Thompson, & Ungerleider, 2010; Akhtar & Menjivar, 2012; Barac, Bialystok, Castro, & Sanchez, 2014; Bialystok, 2001; Bialystok, Craik, Green, & Gollan, 2009; Genesee & Nicoladis, 2007; Grosjean & Li, 2013; Hilchey & Klein, 2011; Kroll & Bialystok, 2013; Nicoladis, 2008; Oller & Eilers, 2002; Paap, 2014; Siegal & Surian, 2012). Two main outcomes have been reported in this research: negative effects of bilingualism on aspects of language development and positive effects on domains of non-verbal cognitive functioning (Adesope et al., 2010; Akhtar & Menjivar, 2012; Bialystok, Luk, Peets, & Yang, 2010; Nicoladis, 2008; Oller & Eilers, 2002). Regarding language, the most widely-reported correlate of bilingualism is vocabulary acquisition, with bilingual children typically exhibiting smaller vocabularies in each of their languages than comparable monolinguals. Non-linguistic cognitive correlates include an enhancement of EC skills in bilingual children.

In the present study we compare the EC performance of bidialectal or, rather, bilectal children (to use the term introduced by Rowe & Grohmann, 2013) speaking Cypriot Greek and Standard Modern Greek to that of multilingual and monolingual Greek-speaking children. The linguistic profile of bilectal children as speakers of two minimally distant (in terms of structural and lexical similarity) and genetically related linguistic varieties, offers a unique opportunity to address one of the pending questions in the literature on the cognitive effects of bilingualism—namely,

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whether close typological proximity between the language pairs spoken by bilinguals modulates these outcomes in any way.

1.2. The effect of bilingualism on EC

Bilingualism and its relation to non-linguistic cognitive functioning has been one of the most active areas of research in the last ten years (see Barac et al., 2014; Kroll & Bialystok, 2013). A widely reported empirical finding of this research is an enhancement of EC skills in bilingual children (e.g. Bialystok, 1999, 2011; Calvo & Bialystok, 2014; Carlson & Meltzoff, 2008; Martin-Rhee & Bialystok, 2008; Morales, Calvo, & Bialystok, 2013; Poarch & van Hell, 2012; though see e.g. Duñabeitia et al., 2014; Hilchey & Klein, 2011; Morton & Harper, 2007; Paap, 2014).

EC refers to a domain-general cognitive system in the prefrontal cortex, which is critical for the flexibility and regulation of cognition and goal-directed behavior (Best & Miller, 2010; Best, Miller, & Jones, 2009). Even though there is no broad consensus regarding its precise components and the degree to which they are related, a widely accepted framework is that proposed by Miyake et al. (2000). According to this account EC comprises three core cognitive processes that are distinguishable but yet moderately interrelated (the *unity and diversity* view): *switching* (the ability to flexibly switch between rules, representations, or tasks), *working memory*[1] (the ability to simultaneously maintain and manipulate task-relevant information in mind), and *inhibition* (the ability to suppress dominant or automatic responses and to resolve conflict by suppressing irrelevant information). Recently, Miyake and Friedman (2012) refined this model by suggesting that there is no separable inhibition factor.

Bilingual advantages in EC performance have been observed throughout the first years of life, for infants (Kovács and Mehler, 2009), pre-schoolers (e.g. Carlson & Meltzoff, 2008; Yang, Yang, & Lust, 2011), and school-aged children (e.g. de Abreu, Cruz-Santos, Tourinho, Martin, & Bialystok, 2012). Advanced EC skills have been hypothesized to (at least partly) underlie bilingual children's superior performance in a wide variety of linguistic and, even more importantly, non-linguistic tasks, demonstrating a generalized bilingual cognitive advantage that extends beyond the linguistic domain: the Simon task (e.g. Martin-Rhee & Bialystok, 2008; Poarch & van Hell, 2012), the Attentional Networks task (e.g. Yang et al., 2011), the Stroop task (e.g. Poulin-Dubois, Blaye, Coutya, & Bialystok, 2011), the Dimensional Change Card Sort task (Bialystok, 1999), false-belief and appearance-reality Theory of Mind tasks (e.g. Bialystok & Senman, 2004; Goetz, 2003; Kovács, 2008), and metalinguistic tasks where a distinction between form and meaning must be made (Bialystok, 1988), to name but a few examples. It is worth noting, however, that some researchers have raised concerns about the very validity of these cognitive benefits (e.g. Duñabeitia et al., 2014; Morton & Harper, 2007; Paap, 2014; Paap & Sawi, 2014; Paap, Johnson, and Sawi, 2014), though it is not yet clearly understood why the effects do (not) appear in some studies.

Earlier work (e.g. Bialystok, 2001; Bialystok et al., 2009) proposed that the bilingual advantage in EC tasks is found in inhibition. However, subsequent researchers have considered alternative explanations. Costa, Hernández, Costa-Faidella, and Sebastián-Gallés (2009) proposed that the bilingual advantage in interference tasks might be better characterized in terms of an enhanced executive system whose main responsibility is to monitor for the presence of conflict. On the other hand, recent work by Bialystok (2011) attributes the bilingual advantages to a better ability to coordinate or jointly recruit the different EC components (see also Kroll & Bialystok, 2013).

1.3. The effect of typological similarity between the language pairs spoken by bilinguals on EC

The available experimental evidence so far seems to support the view that any combination of languages, irrespective of degree of typological proximity, leads to EC benefits in bilinguals. In a meta-analysis of studies on the cognitive correlates of bilingualism, Adesope et al. (2010) reported that bilingualism had a statistically detectable effect on a combined score of attention and representation measures (including attentional control, problem-solving, abstract, and symbolic representation measures), irrespective of the language pairs spoken by bilinguals (including language pairs as diverse as English–French and English–Chinese). Their conclusion is that any combination of languages (and thus any degree of typological distance between two languages) can lead to general cognitive advantages in bilinguals. A similar conclusion was reached by Barac et al. (2014:13) in their critical review of the literature on the cognitive development of preschool-aged bilingual children (see also Barac & Bialystok, 2012).

The results of the studies conducted by Costa, Hernández, and Sebastián-Gallés (2008), Costa et al. (2009), Garbin et al. (2010), Hernández, Costa, Fuentes, Vivas, and Sebastián-Gallés (2010), and Hernández, Martin, Barceló, and Costa (2013) lend weight to the expectation that even bilectal speakers might show advantages in their EC skills. These studies compared the EC performance of Spanish–Catalan bilingual adults to that of Spanish monolinguals. Spanish and Catalan are two closely related Romance languages with a high degree of similarity on all levels (see Appendix B in Costa, Hernández, & Sebastián-Gallés, 2008). As an indication of the lexical proximity between the two languages, Costa et al. (2008) report that 70% of the translation equivalents in the two languages could be considered cognates. Similarly, *Ethnologue* reports a lexical similarity of 85% between the two languages, exactly on the cut-off point for two varieties being dialects of the same language (Lewis, Fennig, & Gary, 2014; see *Dialects* under the *Catalan language* entry).[2]

Costa et al. (2008) administered the adult version of the Attentional Networks Task (henceforth, ANT) and reported a bilingual advantage in the efficiency of two attentional networks: alerting and EC (Costa et al., 2008:82). Hernández et al. (2010) found a bilingual advantage in EC using a Stroop-like task but no differences between bilinguals and monolinguals in the alerting attentional component using a visual cueing task. In a subsequent study, Costa et al. (2009) further explored the bilinguals' superior performance in the ANT and found a bilingual advantage in overall reaction times only in the high-monitoring versions of the task. The authors argue that their results indicate a positive bilingual effect on monitoring skills.

Garbin et al. (2010) administered a non-verbal switching test and reported that bilingual adults exhibited a significantly smaller switching cost than monolinguals that was evident in both accuracy and reaction times. In three subsequent experiments, however, Hernández et al. (2013) failed to replicate the bilingual advantage in switching using various (more or less demanding) versions of a switching task. Rather, they reported a bilingual

[1] Miyake et al. (2000) use the terms *shifting* and *updating and monitoring of working memory representations* instead of *switching* and *working memory*, which are used here. We use the latter set of terms because these are more commonly used in the literature.

[2] According to *Ethnologue*, "the percentage of lexical similarity between two linguistic varieties is determined by comparing a set of standardized wordlists and counting those forms that show similarity in both form and meaning. Percentages higher than 85% usually indicate a speech variant that is likely a dialect of the language with which it is being compared. Unlike intelligibility, lexical similarity is bidirectional or reciprocal." (Lewis et al., 2014; see *Dialects* in the section *Language Information*). It is not clear, however, why this percentage of lexical similarity is suggested as the cut-off point for distinguishing between dialects and languages.