**Critical Review**

# Bilingual Proficiency: A Modulator of Inhibitory Control Processes in Attention-Deficit/Hyperactivity Disorder?

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**Introduction**

Numerous studies have demonstrated that proficient bilingualism is correlated with a wide range of cognitive benefits in people of all ages. In preschoolers, bilinguals outperform monolinguals on tasks of attention-switching (Bialystok & Martin, 2004; Carlson & Meltzoff, 2008); in young adults, bilingualism is associated with faster and more accurate resolution of conflicting information (Costa et al., 2008); and in older adults, bilingualism has been recently identified as a protective factor against pathological aging that can delay the onset of dementia by an average of four years (Bialystok et al., 2007). Overall, there is a profusion of data suggesting that second language proficiency leads to enhanced performance in tasks assessing both verbal and nonverbal competency (Bialystok, 2001). By contrast, there is sparse research on the disadvantages associated with bilingualism. Earlier studies demonstrating bilingual impairment were confounded by extraneous variables like poor education and low socioeconomic status (Peal & Lambert, 1962). Today, studies demonstrating the negative effects of bilingualism are narrowly focused on reduced lexical access (Gollan et al., 2011; Ransdell & Fischler, 1987), increased tip-of-the-tongue retrieval failures (Gollan & Silverberg, 2001) or reduced verbal fluency (Portocarrero et al., 2007). Critically absent from the literature is how bilingualism affects the prognosis and presentation (neural and behavioral) of developmental disorders. Of interest to this paper: Do developmental disorders manifest differently in monolinguals versus bilinguals? In particular, is second language proficiency a predictor of functional outcome in attention-deficit/hyperactivity disorder (ADHD)? Toppelberg et al (1999) has identified the relationship between psychopathology and bilingualism as a field of interest and Bialystok (2010) has noted that ADHD is especially worthy of further investigation, but the topic is still in its infancy. Currently, there has only been one study investigating their

relationship (Mor et al., 2014). I propose that it is important to elucidate the relationship of bilingualism to ADHD because it is unknown whether the executive control impairments in ADHD children are ameliorated or diminished by the enhanced executive control that has been extensively documented in bilinguals. Accordingly, a resolution of this issue may profoundly impact clinical and educational initiatives for ADHD children. The aim of this paper is threefold:

1. To demonstrate a relationship between bilingualism and ADHD;
2. To show that inhibitory executive control processes underlie that relationship;
3. To identify second language *proficiency* (instead of a dichotomous bilingualism/monolingualism categorization) as a critical modulator of ADHD outcome.

Ultimately, this review will argue that bilingualism modulates ADHD such that proficient bilingualism leads to advantageous outcomes and non-proficient bilingualism leads to disadvantageous outcomes in pathological development.

**Executive Function and the Bilingual Advantage:**

Stuss (1992) describes executive control as a group of cognitive skills that include the ability to formulate plans, manipulate information in working memory, and inhibit impulsive responses. The positive benefits conferred by bilingualism are primarily ascribed to enhanced functioning in this executive domain. Using Stroop tasks (1935) and Simon tasks (1967), researchers have demonstrated that bilinguals are more adept at suppressing competing information than are monolinguals (Bialystok, Craik, Klein, & Visvanathan, 2004). According to Green (1998), this enhanced inhibitory control results from the consistent practice that bilinguals have in attending to information from one language whilst ignoring information from the other language. Consistent with this hypothesis, subsequent research has indicated that

bilingual speakers jointly activate both languages and must resolve language competition by selectively modulating their engagement (Dijkstra et al.,1998; Colome, 2001; Philipp & Koch, 2009). The outstanding question is whether the same conclusions can be applied to bilingual children with ADHD. Since the executive control network underlying bilingualism also mediates attentional resources in ADHD, the two areas of development are thusly linked.

**Executive Function and Attention-Deficit/Hyperactivity Disorder (ADHD):**

Barkley's (1997) seminal work on ADHD proposed that the disorder is primarily characterized by poor self-regulation, specifically the impaired ability to inhibit information. Likewise, Logan et al (2002) and Wodushek & Neumann (2003) argue that a deficiency in inhibitory processes is the defining criterion of ADHD. More generally, ADHD is associated with weaker performance in tasks that purport to measure executive function. Wilcutt et al (2005) conducted a meta-analysis which indicated that children and young adults with ADHD exhibit deficits in inhibitory control, problem solving, and strategic planning.

This pattern appears to persist across the lifespan. When parents rate their preschool-age children on measures of executive function, poor inhibition emerges as a reliable predictor of ADHD symptoms (Skogan et al., 2015). Furthermore, the poor inhibitory control associated with ADHD extends beyond just poor performance on laboratory tasks of executive control. There are adverse consequences observed in social, academic, and health functioning. For instance, people with ADHD are less likely to pursue post-secondary education (Mannuzza et al., 1997) and are more likely to develop substance-abuse disorders (Lee et al., 2011).

The juxtaposition of superior inhibitory control processes in bilingualism and inferior inhibitory control processes in ADHD raises an important question: Will the executive

advantages conferred by second language proficiency result in less severe attentional deficits for bilinguals with ADHD? That is, will bilingualism assist ADHD students in obtaining similar levels of cognitive performance to their peers without ADHD?

**Previous Research:**

Mor et al's (2015) investigation of the aforementioned questions is the first of its kind. They hypothesized that the advantages conferred by bilingualism would have an alleviatory impact on ADHD, so that bilinguals with ADHD would exhibit better executive control than monolinguals with ADHD. In essence, the skills associated with multiple language engagement would mediate pathological outcomes. University students were assessed on two measures of executive functioning: i) inhibition and ii) shifting. Overall, the data showed that people with ADHD performed worse than controls.

However, contrary to the researchers' predictions, bilinguals with ADHD did *not* show an advantage over monolinguals with ADHD. In the shifting tasks, language skills did not mediate performance. Most surprisingly, bilinguals showed *impaired* performance in the inhibitory tasks, leading the authors to tentatively conclude that bilingualism might serve an impedimentary function in ADHD. Specifically, the inhibition tasks revealed that bilinguals with ADHD had lower speed and accuracy than bilingual controls, and that monolinguals with ADHD had equivalent speed but lower accuracy than monolingual controls. According to Mor et al (2015), monolinguals with ADHD were able to compensate for their inhibitory control deficits by selectively focusing on a singular aspect of performance (speed), whereas bilinguals with ADHD were not able to compensate for their impaired functioning in either speed or accuracy.

In light of the robust information linking bilingualism to enhanced inhibitory control (Bialystok, 2010), this unexpected outcome challenges previously established information. Why should the bilingual advantage not extend to people with ADHD? The authors proffer a few explanations: Firstly, the results might be a function of inaccurate ADHD screening methods (exacerbated by cultural differences between the monolingual and bilingual populations) or ill-defined language definitions (the bilingual participants did not have balanced proficiency in each language and the monolingual participants were not 'pure' monolinguals). Secondly, the bilingual deficit in ADHD participants might stem from the difficulties in attending to multiple language systems.

As discussed previously in this paper, bilinguals jointly activate both language systems and are thus consistently suppressing the interference from the irrelevant language (Dijkstra et al.,1998; Colome, 2001; Philipp & Koch, 2009). In individuals without attentional deficits, this leads to superior executive control. However, the additive effects of ADHD attentional switching and bilingual language shifting might 'overload' the executive control system, resulting in the observed bilingual disadvantage. Clearly, the validity and applicability of this theory is indeterminate and further research is needed. In the absence of definitive evidence, I propose an alternate theory: second language *proficiency* (instead of a dichotomous bilingual/monolingual categorization) might mediate inhibitory processes in ADHD individuals.

**Language Proficiency as a Modulator of Inhibitory Control in ADHD:**

Inherent to the concept of a bilingual advantage in executive functioning is the frequent and proficient usage of both languages. Logic dictates that the regular attentional switching between two languages must be employed frequently if it is to significantly result in increased

inhibitory control. However, Yow & Li (2015) note that there is a critical gap in bilingualism literature such that the participants' second language proficiency is typically not specified. Although bilingualism exists on a spectrum, it is often conceptualized categorically. Accordingly, Yow & Li hypothesized that improved executive functioning might be modulated by the *degree* of bilingualism. Specifically, they demonstrated that the i) early acquisition of two languages and the ii) more frequent use of two languages was associated with improved executive functioning because participants who possessed this 'balanced bilingualism' language profile had increased practice in routing their attention to the relevant language system. I propose that this theory can similarly be applied to individuals with ADHD: the age of second language acquisition, as well as proficiency and frequency of use, should influence executive control processes.

It is important to note that the interaction between language acquisition and psychopathology is complex. According to Saville-Troike (1998), children acquire a second language through a diverse and conscious activation of linguistic and cognitive strategies. Toppelberg et al (1999) further suggest that the constraints typically associated with normal language learning are exacerbated in children with developmental disabilities. While it is plausible that the linguistic strategies normally used in second language acquisition are compromised by psychopathology (Toppelberg et al., 2002), it is also possible that bilingual skills reduce/offset psychopathology in a way similar to their mitigatory effect on pathological aging (Bialystok et al., 2007). Again, the heterogeneity of psychopathology necessitates further investigation into the field; it is expected that bilingualism interacts with ADHD in a manner distinct from its interaction with - for example- autism or dyslexia.

Critically, the distinction must be drawn between low and high language proficiency, regardless of whether the individual is monolingual or bilingual. Since poor language skills predict adverse social and academic outcomes in monolingual children (Beitchman, 1996), it follows that low *bilingual* proficiency is associated with the same detriments. That is, bilingual proficiency must be high in order to reap the benefits of the 'bilingual advantage'.

To provide a relevant example: consider the bilingual immigrant child who is reared in a household where the parents fail to provide sufficient linguistic stimuli from language one and who is taught in a school where he does not develop sufficient competency in language two. Although this child might be classified as 'bilingual', it is evident that he does not have the same level of proficiency as a bilingual child who possesses a high verbal fluency in both languages. Whereas the latter child will regularly and masterfully exert his control processes in the engagement and suppression of each language, the former child will suffer from the inability to inhibit competing information. Consequently, the development of ADHD will differ in each child (and might even *predispose* the former child to the disorder!).

The fundamental tenet of the bilingual advantage theory is enhanced inhibitory control and it is thus vital for future research to account for the differing levels of proficiency that might impact these inhibition processes.

**Conclusion:**

A synthesis of the data linking increased inhibitory control to bilingualism and decreased inhibitory control to ADHD strongly suggests that there is a relationship between bilingualism and ADHD that is modulated by the executive control network. Whether bilingualism exacerbates the inhibitory deficits in ADHD, reduces the inhibitory deficits in ADHD, or predisposes an individual to ADHD is unknown. A thorough exculpation of this relationship

will likely demonstrate that bilingualism does not uniformly confer executive functioning advantages in people with ADHD. Rather, its manifestation is contingent upon the quality and quantity of second language skills. As such, bilingual language screening should be encouraged in children who exhibit ADHD symptomatology. Lastly, acknowledging the heterogeneity of linguistic ability has important implications for children, so that treatment and education programs can be designed to maximally benefit the language profile of each individual child.

**References**

Barkley, R. A. (1997). ADHD and the nature of self-control. New York: Guilford Press.

Beitchman, J. H., Wilson, B., Brownlie, E. B., Walters, H., Inglis, A., Lancee, W. (1996) Long-term consistency in speech/language profiles, II: behavioral, emotional, and social outcomes. Journal of the American Academy of Child and Adolescent Psychiatry, 35 (6), 815–825.

Bialystok, E. (2001). Bilingualism in development: Language, literacy, and cognition. New York: Cambridge University Press.

Bialystok, E., & Martin, M. M. (2004). Attention and inhibition in bilingual children: Evidence from the dimensional change card sort task. Developmental Science, 7, 325-339.

Bialystok, E., Craik, F.I.M., & Freedman, M. (2007). Bilingualism as a protection against the onset of symptoms of dementia. Neuropsychologia, 45, 459-464.

Bialystok, E. (2010), Bilingualism. Wiley Interdisciplinary Reviews: Cognitive Science, 1: 559–572. doi: 10.1002/wcs.43

Carlson, S. M., & Meltzoff, A. M. (2008). Bilingual experience and executive functioning in young children. Developmental Science, 11 (2), 282–298.

Colomé, A. (2001). Lexical activation in bilinguals' speech production: language-specific or language-independent? Journal of Memory and Language;45, 721–736.

Costa, A., Hernandez, M., Sebastian-Galles, N. (2008). Bilingualism aids conflict resolution: evidence from the ANT task. Cognition, 106 (1), 59-86.

Dijkstra, T., van Jaarsveld, H., & Ten-Brinke, S. (1998). Interlingual homograph recognition: Effects of task demands and language intermixing. Bilingual Language Cognition, 1, 51–66

Green, D. W. (1998) Mental control of the bilingual lexicosemantic system. Bilingual Language Cognition,1, 67–81.

Gollan, T. H., & Silverberg, N. B. (2001). Tip-of-the-tongue states in Hebrew-English bilinguals. Bilingualism: Language and Cognition, 4, 63–83.

Gollan, T. H., Slattery, T. J., Goldenberg, D., van Assche, E., Duyck, W., & Rayner, K. (2011). Frequency Drives Lexical Access in Reading but not in Speaking: The Frequency-Lag Hypothesis. Journal of Experimental Psychology. General, 140(2), 186–209. doi:10.1037/a0022256

Lee, S.S., Humphreys, K.L., Flory, K., Liu, R., & Glass, K. (2011). Prospective association of childhood attention-deficit/hyperactivity disorder (ADHD) and substance use and

abuse/dependence: a meta-analytic review," Clinical Psychology Review, 31( 3), 328–341.

Logan, G.D., Schachar, R.J., & Tannock, R. (2000). Executive control problems in childhood psychopathology: stop signal studies of attention deficit hyperactivity disorder. In S. Monsell & J. Driver (Eds), Control of Cognitive Processes: Attention and performance. Cambridge, MA: Bradford.

Mannuzza, S., Klein, R. G., Bessler, A., Malloy, P., & Hynes, M. E. (1997). Educational and occupational outcome of hyperactive boys grown up. Journal of the American Academy of Child and Adolescent Psychiatry,36 (9), 1222–1227.

Mor, B., Yitzhaki-Amsalem, S. & Prior, A. (2014). The joint effect of bilingualism and ADHD on executive functions. Journal of Attention Disorders. doi:10.1177/1087054714527790.

Peal, E., & Lambert, W. E. (1962). The relation of bilingualism to intelligence. Psychological Monographs, 76, 1-23.

Philipp, A.M., & Koch, I. (2009). Inhibition in language switching: what is inhibited when switching between languages in naming tasks? Journal of Experimental Psychology, 35 (5), 1187-1195.

Portocarrero, J.S., Burright, R.G., Donovick, P.J. (2007). Vocabulary and verbal fluency of bilingual and monolingual college students. Clinical Neuropsychology, 22 (3), 415-422.

Ransdell, S. E., & Fischler, I. (1989). Effects of concreteness and task context on recall of prose among bilingual and monolingual speakers. Journal of Memory and Language, 28, 278-291.

Saville-Troike, M. (1988) Private speech: evidence for second language learning strategies during the "silent period. Journal of Child Language, 15, 567–590.

Simon J. R., Rudell A. P. (1967). Auditory S-R compatibility: the effect of an irrelevant cue on information processing. Journal of Applied Psychology, 51, 300–304. doi 10.1037/h0020586

Skogan, A. H., Zeiner, P., Egeland, J., Urnes, A.-G., Reichborn-Kjennerud, T., & Aase, H. (2015). Parent ratings of executive function in young preschool children with symptoms of attention-deficit/-hyperactivity disorder. Behavioral and Brain Functions : BBF, 11, 16. doi:10.1186/s12993-015-0060-1

Stroop J. R. (1935). Studies of interference in serial verbal reactions. Journal of Experimental Psychology,18, 643–662. doi 10.1037/h0054651.

Stuss, D. T. (1992). Biological and psychological development of executive functions. Brain and Cognition, 20, 8-23.

Toppelberg, C. O., Snow, C. E., & Tager-Flusberg, H. (1999). Severe Developmental Disorders and Bilingualism. Journal of the American Academy of Child and Adolescent Psychiatry, 38(9), 1197–1199.

Toppelberg, C.O., Medrano, L., Morgens, L. P., & Nieto-Castanon, A. (2002). Bilingual Children Referred for Psychiatric Services: Associations of Language Disorders, Language Skills, and Psychopathology. Journal of the American Academy of Child & Adolescent Psychiatry, 41(6), 712–722.

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S.V., & Pennington, B. F. (2005). Validity of the executive function theory of Attention-Deficit/Hyperactivity Disorder: A meta analytic review. Biological Psychiatry, 57(11), 1336–1346.

Wodushek, T, R., & Neumann, C.S. (2003). Inhibitory capacity of adults with symptoms of attention deficit -hyperactivity disorder (ADHD). Clinical Neuropsychology, 18, 317-330.

Yow, W. Q., & X, Li. (2015). Balanced bilingualism and early age of second language acquisition as the underlying mechanisms of a bilingual executive control advantage: why variations in bilingual experiences matter. Frontiers in Psychology, 6, 664-1078.