Developmental Review ■■ (2014) ■■–■■

Contents lists available at ScienceDirect

Developmental Review

journal homepage: www.elsevier.com/locate/dr

Bilingualism as a model for multitasking

Gregory J. Poarch, Ellen Bialystok *

Department of Psychology, York University, Toronto, ON, Canada

ARTICLE INFO

Article history:
Received 4 December 2014
Available online

Keywords:
Bilingualism
Executive functions
Multitasking
Task switching
Dual-task performance
Monitoring
Attention
Inhibition

ABSTRACT

Because both languages of bilinguals are constantly active, bilinguals need to manage attention to the target language and avoid interference from the non-target language. This process is likely carried out by recruiting the executive function (EF) system, a system that is also the basis for multitasking. In previous research, bilinguals have been shown to outperform monolinguals on tasks requiring EF, suggesting that the practice using EF for language management benefits performance in other tasks as well. The present study examined 203 children, 8–11 years old, who were monolingual, partially bilingual, bilingual, or trilingual performing a flanker task. Two results support the interpretation that bilingualism is related to multitasking. First, bilingual children outperformed monolinguals on the conflict trials in the flanker task, confirming previous results for a bilingual advantage in EF. Second, the inclusion of partial bilinguals and trilinguals set limits on the role of experience: partial bilingual performed similarly to monolinguals and trilinguals performed similarly to bilinguals, suggesting that degrees of experience are not well-calibrated to improvements in EF. Our conclusion is that the involvement of EF in bilingual language processing makes bilingualism a form of linguistic multitasking.

Introduction

Roughly half of the world's population is bilingual or multilingual, with many more in the process of becoming bilingual (Bhatia & Ritchie, 2013). Thus, a significant portion of people regularly exist in

* Corresponding author. Department of Psychology, York University, Toronto, ON, Canada M3J 1P3. Fax: +1 416 736 5814.
E-mail address: ellenb@yorku.ca (E. Bialystok).

http://dx.doi.org/10.1016/j.dr.2014.12.003
0273-2297/

Please cite this article in press as: Gregory J. Poarch, Ellen Bialystok, Bilingualism as a model for multitasking, Developmental Review (2014), doi: 10.1016/j.dr.2014.12.003

a sustained and unique dual-language situation: Every act of language processing calls for the recruitment of mental resources to control attention to two (or possibly more) languages. We shall argue that this bilingual situation constitutes a special type of multitasking and that the consequences of this linguistic multitasking may have implications for understanding other dual task situations that children encounter in development.

There is substantial converging evidence that both languages in bilinguals are constantly active to some degree even if only one is supported by the environment (for review, see Kroll, Dussias, Bogulski, & Valdes-Kroff, 2012). Therefore, in order to ensure fluent language processing without intrusions from the unwanted language there needs to be a cognitive mechanism that controls attention to the two jointly activated systems and selects correctly for the context. The system generally attributed with this function is the executive control or executive function (EF) system (Abutalebi & Green, 2008), a set of processes situated in the frontal lobes (Stuss, 2011; Stuss & Benson, 1986). In an influential analysis of the construct, Miyake and colleagues (Miyake & Friedman, 2012; Miyake et al., 2000) identified three core components of EF: (1) monitoring and mental set shifting, (2) updating and working memory, and (3) selective attention and inhibition. All these components are immature in infants and develop slowly across early childhood (e.g., Garon, Bryson, & Smith, 2008).

Central to this argument is the assumption that both languages are jointly activated, creating the need for a cognitive mechanisms to avoid intrusion even when bilinguals are in exclusively monolingual settings. There is substantial evidence for this claim that includes studies with participants of different ages, speaking different languages, and using different empirical methodologies (e.g., Poarch & Van Hell, 2012a; Rodriguez-Fornells, Rotte, Heinze, Nösselt, & Münte, 2002; Thierry & Wu, 2007; Van Heuven, Schriefers, Dijkstra, & Hagoort, 2008). For example, in a study with Russian–English bilinguals conducted by Marian, Spivey, and Hirsch (2003), eye movements were recorded during an English-only task. Participants saw a display of four pictures and were asked to make an eye movement toward the one that was named, but pictures whose Russian names sounded like the English target word elicited a significant number of initial eye movements. Thus, an instruction to look at the "marker" elicited eye movements to a picture of a stamp, called "marka" in Russian. Therefore, in spite of all instructions and all test materials being in English and despite the English context in which the experiment was conducted, performance of the bilinguals was influenced by Russian, a language not required for the task or by the context.

Other evidence for dual-language activation was found in a go/no-go task using event-related potentials (ERP). Wu and Thierry (2012) asked Chinese–English bilinguals to make visual form judgments on shapes (go), while withholding a response when an English word was shown (no-go). During the task, a shape appeared on the screen and participants were instructed to press one of two buttons to indicate whether it was a circle or a square (go) while intervening English words were presented with instruction to refrain from pressing either button (no-go). Critically, some of these to-be-ignored English words resembled the sound of the Chinese translations of the words for "circle" (yuán) or "square" (fāng). For example, one of the stimuli was the English word 'reason', for which the Chinese translation is 'yuán yin'. On these trials, participants were influenced by the irrelevant word and chose the button press associated with the word rather than the shape, similar to the interference in a Stroop task. In the control condition, there was no phonological or semantic relation between the English words, their translation equivalent in Chinese, and the subsequent shape. Event-related potential amplitudes revealed greater inhibitory processing in the conflict trials than in the control condition. The authors interpreted this pattern as indicating parallel access to translation equivalents in the native language during involuntary second language processing in a nonverbal task. At the same time, this dual activation also necessitated rapid inhibition of the first language (Chinese) to avoid adversely affecting performance in the nonverbal task.

Bilingualism and executive functioning

It is the joint activation of the two languages that creates the need for the recruitment of EF in ordinary linguistic tasks by bilinguals. Crucially, multitasking is also strongly dependent on EF. The central argument, therefore, is that bilingual language use is a special case of multitasking and the claim is that the use of EF to manage attention to two languages strengthens EF processes for other

Please cite this article in press as: Gregory J. Poarch, Ellen Bialystok, Bilingualism as a model for multitasking, Developmental Review (2014), doi: 10.1016/j.dr.2014.12.003