Journal of Neurolinguistics 46 (2018) 78–92

Contents lists available at ScienceDirect

Journal of Neurolinguistics

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

Task strategy may contribute to performance differences between monolinguals and bilinguals in cognitive control tasks: ERP evidence

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ARTICLE INFO

Keywords:
Bilingualism
Executive control
LANT
Task strategy
ERN
CRN

ABSTRACT

A bilingual advantage in the efficiency of executive control in young adults has been demonstrated in many but not all studies. We aimed to test the efficiency of executive control in a lateralized version of the Attentional Network Task and to investigate accompanying ERP components. The performance of young adult bilinguals who acquired their L2 relatively late but were balanced in proficiency and daily usage of L1 and L2 was compared with that of young adults who reported low proficiency and marginal daily usage of L2. Balanced bilinguals were more accurate in the incongruent condition and at the same time as fast as the control group across conditions. Interestingly, in comparison to the control group, the bilingual group demonstrated more enhanced response-locked negativities to both incorrect (ERN) and correct responses (CRN). The obtained pattern of results suggests that the groups may have differed in terms of task strategies. Bilinguals may have controlled their performance more effectively, which resulted in their better conflict resolution, as compared to the control group. In conclusion, we point to the importance of considering qualitative differences in task processing and strategy while studying group differences - an approach rarely considered in current research on executive functions in bilinguals.

1. Introduction

In recent years, the hypothesis that bilingualism may enhance executive control has been highly disputed. The superior performance of bilinguals in tasks measuring executive control has been reported across many, but not all studies (e.g. see Paap, Johnson, & Sawi, 2015; Valian, 2015; for a recent discussion on this topic). This lack of consistency in the literature generates a need for more refined questions about the exact nature of the potential benefit of bilingualism and leads to the formulation of new hypotheses about the interaction between specific language experience and executive control (e.g. Dong & Zhong, 2017; Green & Abutalebi, 2013).

A bilingual advantage in the efficiency of executive control has been found in children (Bialystok & Martin, 2004), adults (Bialystok and Craik et al., 2005; Costa, Hernández, & Sebastián-Gallés, 2008) and the elderly (Bialystok, Craik, Klein, &

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https://doi.org/10.1016/j.jneuroling.2017.12.013
Received 30 January 2017; Received in revised form 28 December 2017; Accepted 28 December 2017

Viswanathan, 2004; Wodniecka, Craik, Luo, & Bialystok, 2010). However, the magnitude of the effect substantially varies across different age groups (Bialystok, Martin, & Viswanathan, 2005). In the present paper, we focused on young adults for whom results have been especially inconsistent. While some studies have reported a bilingual advantage in this age group (e.g. Costa et al., 2008; Marzecová, Asanowicz, Krivá, & Wodniecka, 2013), others have failed to observe this effect (e.g. Kousaie & Phillips, 2012). A meta-analysis conducted by Donnelly, Brooks, and Homer (2015) revealed that a bilingual advantage in young adults is the hardest to observe and replicate. Following the developmental trajectory of executive control, it has been proposed that cognitive benefits in young adult bilinguals may not be observable because young adults are at the peak of their cognitive abilities and, thus, may not show any additional benefits of being bilingual (e.g. Bialystok & Barac, 2012).

Investigations of young adults are further complicated by the fact that various experimental paradigms have been used to examine the cognitive consequences of bilingualism. Since different experimental paradigms may tap into functionally different components of executive control (see Marzecová, 2015; Paap et al., 2015; for a discussion), it is often hard to disentangle the sources of discrepancy in results across studies. In this paper, we focus on the task that has been used in several previous studies on the cognitive consequences of bilingualism in young adults: The Attentional Network Task (ANT; Costa, Hernández, Costa-Faidella, & Sebastián-Gallés, 2009; Costa et al., 2008).

The ANT allows for a reliable assessment of the efficiency of the three attentional networks (alerting, orienting, and executive) that subserve three different functions (maintenance of alertness, orienting, and executive control; Fan, McCandliss, Sommer, Raz, & Posner, 2002, and see MacLeod et al., 2010, for a detailed analysis of psychometric properties of the ANT). In the ANT, participants are asked to resolve a classical flanker conflict: identify the target stimulus while ignoring the flanking stimuli. The flanking stimuli may be the same as the target (congruent condition; e.g. → → → → →) or different (incongruent condition; e.g. → → ← → →). Incongruent trials lead to slower reaction times and less accurate responses, presumably because the flanking stimuli and the target are associated with different responses. In order to respond correctly, participants must resolve this conflict. Within the ANT, difference in performance between the incongruent and the congruent condition is assumed to reflect efficiency of executive control (Fan et al., 2002); for this reason, this task has been often employed in studies on bilingualism. Although the task has also been used to study younger populations (e.g. Antón et al., 2014), below we summarize only the results concerning young adults to allow direct comparison with the current study.

In two ANT studies conducted by Costa et al. (2009, 2008), young adult Catalan–Spanish bilinguals who acquired their second language (L2) early were compared with young Spanish functional monolinguals. In the first study (Costa et al., 2008), faster reaction times (RT) of bilinguals in the incongruent condition were interpreted as reflecting more efficient executive control in young bilinguals. In the second study (Costa et al., 2009), this effect was observed only in a more difficult version of the task (i.e. a high monitoring version of the ANT in which only 25% of trials were incongruent; Experiment 2).

The bilingual advantage in the efficiency of executive control in young adults has also been investigated in studies that employed a lateralized version of the ANT (LANT; Marzecová, Asanowicz et al., 2013; Marzecová, Bukowski et al., 2013; Tao, Marzecová, Taft, Asanowicz, & Wodniecka, 2011). The LANT appears to impose a greater conflict than the classic ANT due to its peripheral presentation of stimuli (see Asanowicz, Marzecová, Jaśkowski, & Wolski, 2012; Tao et al., 2011; for justification). In the study conducted by Tao et al. (2011), three groups of young adults were compared: English monolinguals and both early and late Chinese–English bilinguals. Both late and early bilinguals revealed more efficient executive control in RT compared to monolinguals, but the late bilinguals (who were also more balanced in the proficiency and use of L1 and the L2) were significantly more efficient in RT than the early bilinguals. Additionally, late bilinguals showed more efficient executive control in their accuracy, whereas no difference in the accuracy measure was reported between the early bilinguals and monolinguals. In the other study conducted by Marzecová, Asanowicz et al. (2013), Marzecová, Bukowski et al. (2013), Polish monolinguals were compared to early bilinguals who were speakers of different Slavic languages; the bilinguals were found to have more efficient executive control in RT and, marginally, in accuracy, as compared to monolinguals.

The peripheral presentation of stimuli in the LANT not only increases the difficulty of the task, but also allows the interhemispheric organization of executive control to be examined. Several previous studies have indicated that bilinguals reveal reduced hemispheric asymmetry for both verbal (Dehaene et al., 1997; Moreno, Bialystok, Wodniecka, & Alain, 2010) and non-verbal cognitive functions (Hausmann, Durmusoglu, Yazgan, & Gunturkun, 2004). In particular, studies that employed the LANT (i.e. Marzecová, Asanowicz et al., 2013; Marzecová, Bukowski et al., 2013; Tao et al., 2011; described above) have indicated that bilingualism may reduce right hemisphere (left visual field; LVF) dominance for stimuli processing. In the study conducted by Marzecová, Asanowicz et al. (2013), Marzecová, Bukowski et al. (2013), monolinguals revealed right hemisphere dominance for incongruent targets in accuracy, while early bilinguals showed no asymmetry in either of the task conditions. In the study conducted by Tao et al. (2011), both monolinguals and late bilinguals revealed right hemisphere dominance in RT, while early bilinguals showed a strong trend towards reduced hemispheric asymmetry in RT. Based on a comparison of late and early bilinguals, Tao et al. (2011) suggested that early experience in L2 might be especially important for the reduction of right hemisphere dominance. The participants in the study of Marzecová, Asanowicz et al. (2013), Marzecová, Bukowski et al. (2013) were early, relatively balanced young adult bilinguals who used languages that are typologically similar to each other (mostly Czech–Slovak). In contrast, Tao et al. (2011) tested early and late, less balanced young adult bilinguals who used two typologically distinct languages. It remains an open question whether similar effects could be observed in young adult bilinguals with relatively late exposure to two typologically similar languages.

The aim of the current study was to investigate the efficiency of executive control in young bilingual adults using a modified LANT. We tested a group of young adults who acquired their L2 (Polish) relatively late and were balanced in terms of their proficiency and daily usage of L1 and L2 (bilingual group). Performance of bilinguals was compared with that of native speakers of Polish