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Highlights

- Language switching is directly related to executive control advantages
- Frequent language switchers are better at processing conflicting information
- L2 proficiency plays a much smaller role

For Peer Review

1 Language Switching and Executive Control
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4 **Running Head:** Language Switching and Executive Control
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8 **The influence of language switching experience on the bilingual executive control**
9 **advantage**
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Language Switching and Executive Control

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Abstract

In an ongoing debate, bilingual research currently discusses whether bilingualism enhances non-linguistic executive control. The goal of this study was to investigate the influence of language switching experience, rather than language proficiency, on this bilingual executive control advantage. We compared the performance of unbalanced bilinguals, balanced non-switching, and balanced switching bilinguals on two executive control tasks, i.e. a flanker and a Simon task. We found that the balanced switching bilinguals outperformed both other groups in terms of executive control performance, whereas the unbalanced and balanced non-switching bilinguals did not differ. These findings indicate that language switching experience, rather than high second-language proficiency, is the key determinant of the bilingual advantage in cognitive control processes related to interference resolution.

Language Switching and Executive Control

Introduction

About 50% of the world population is considered to be bilingual (Grosjean, 1989). Besides the obvious communicative advantage, several associated and even non-linguistic cognitive benefits of bilingualism have recently been explored. One well-replicated advantage is the finding that bilinguals show improved performance on a broad range of executive control tasks. Here, “executive control” refers to a range of high-level control functions that support goal-directed behaviour. Three main control functions can be identified: inhibition, updating and shifting (Miyake et al., 2000). In what follows, we will summarise earlier evidence pointing towards bilingual advantages for tasks assessing inhibition and shifting functions.

There are several reports that bilinguals outperform monolinguals on a range of tasks tapping into inhibition. Bialystok, Craik, and Luk (2008), for example, observed that bilinguals outperform monolinguals on a Stroop task, an interference inhibition task in which participants have to name the ink colour of colour words (e.g., the word *green* printed in red), while suppressing the natural tendency to read the colour word. Another measure of interference inhibition is the Eriksen flanker task (Eriksen & Eriksen, 1974). This task requires participants to react to the direction of the central of five arrows (<<>><<), while trying to ignore the direction of the four flanking arrows. Bilinguals outperform monolinguals on this task as well (Costa, Hernandez, & Sebastian-Gallès, 2008). The positive effect of bilingualism on inhibitory control tasks also seems to be an effect that emerges throughout the lifespan. It has been found that bilingual children already show enhanced performance compared to their monolingual peers on tasks tapping into inhibition (Carlson & Meltzoff, 2008). In addition, the advantage remains

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consistent in bilingual elderly (Bialystok, Craik, Klein, & Viswanathan, 2004; Bialystok et al., 2008; Weissberger, Wierenga, Bondi, & Gollan, 2012).

These findings are compatible with a highly influential cognitive account of bilingualism and bilingual language control, the Inhibitory Control Model (Green, 1998). This model assumes that bilinguals experience a continuous competition (conflict/interference) between lexical representations of both languages, which are indeed always active to a certain degree in speaking (Hermans, Bongaerts, De Bot, & Schreuder, 1999), reading (Van Assche, Duyck, Hartsuiker, & Diependaele, 2009) and listening (Lagrou, Hartsuiker, & Duyck, 2011). To resolve this competition, control resources are recruited to inhibit the conflicting activation of the non-target language. Importantly, these inhibitory mechanisms seem to be domain-general¹, so that experience in managing competition between linguistic representations also transfers to non-linguistic tasks (Bialystok et al., 2005; Bialystok, Craik, & Ryan, 2006; Colzato et al., 2008; Costa et al., 2008; Martin-Rhee & Bialystok, 2008). The central role for inhibition also becomes clear from a study by Emmorey, Luk, Pyers, and Bialystok (2009), who reported the performance of bilinguals who know two spoken languages (unimodal bilinguals) and of bilinguals who know both a spoken and a sign language (bimodal bilinguals) in such a flanker paradigm. The clever manipulation here implies that only the unimodal bilinguals have to inhibit representations in the non-target language to be able to achieve lexical selection for production in the target language. Inhibition is not

¹ Whether the EC processes put at play by bilingual language control are fully subsidiary of domain-general EC processes is still a matter of debate. Some studies did not find any correlation between linguistic and non-linguistic tasks (Bialystok, Craik, & Luk, 2008; Calabria, Hernandez, Branzi, & Costa, 2012). However, this issue goes beyond the objective of the present article.

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necessarily required in bimodal bilinguals, because they can both execute the sign and produce the word, even simultaneously if needed. And, indeed, only unimodal bilinguals showed an advantage in the flanker task, suggesting that resolving interlingual competition through inhibition is important for the executive control advantage.

Interestingly, the bilingual advantage on tasks tapping into inhibition is not only measurable on trials that involve competition between relevant and irrelevant information (like incongruent trials or switch trials) but also on trials that require a simple choice reaction without any cognitive conflict (like congruent trials or non-switch trials) (Costa et al., 2008). This finding suggests that the cognitive benefits of bilingualism are not restricted to one specific executive control function, but may be extended to the entire, domain-general executive control system. Indeed, besides inhibitory control, bilinguals also show an advantage on tasks tapping into shifting. i.e., showing smaller shift costs compared to monolinguals (Bialystok & Viswanathan, 2009; Garbin et al., 2010; Prior & Gollan, 2011; Prior & MacWhinney, 2010). Prior and MacWhinney (2010) also found reduced shift costs in the bilingual compared to the monolingual group.

Based on the findings that (a) the bilingual advantage does not only appear in conflict trials, but also in non-conflict trials, and that (b) bilinguals also show enhanced performance on other executive functioning tasks, which do not necessarily tap into inhibition, it was suggested that mastering two languages not only enhanced inhibitory control, but leads to improved executive control functions in general.

Importantly, the mere fact of knowing two languages does not always suffice for enhancing executive control functioning. Luk, De Sa and Bialystok (2011) administered a flanker task in a group of monolinguals, late bilinguals and early bilinguals. Only the

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4 early bilinguals showed better performance on the control task; no difference was found
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6 between the late bilinguals and the early bilinguals. So it seems that being bilingual per se
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8 does not suffice to enhance performance on executive control tasks.
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11 Interestingly, the bilingual executive control advantage was also recently
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13 challenged by a large study of Paap and Greenberg (2013). They compared fairly large
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15 groups of monolinguals and bilinguals on a wide range of 15 executive control tasks.
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17 Although all of the tasks yielded the expected congruency or inhibition effects, none of
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19 these tasks yielded a bilingual advantage, except one task, which actually showed a
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21 bilingual disadvantage. In another recent study (Hernández, Martin, Barceló, & Costa,
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23 2013), the bilingual advantage also failed to show on several measures of task switching,
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25 These null effects, combined with the observation that most of the reported bilingual
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27 advantage reports indeed come from very specific and a limited number of bilingual
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29 populations, suggests that the bilingual advantage does not emerge from bilingualism in
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31 itself, but instead that certain characteristics of language use may be crucial for
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33 development of the control advantage. Currently however, it is unclear what these
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35 language use/learning factors are.
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42 In the current paper, we aim to further clarify one bilingual parameter that may be
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44 crucial for development of the bilingual control advantage. More specifically, we further
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46 investigated the role of language switching in daily life. Indirectly, it was already
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48 suggested in the paper of Emmorey and colleagues (2009) that the amount of (language)
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50 switching might underlie the bilingual executive control advantage. They hypothesised
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52 that the difference in control performance between unimodal and bimodal bilinguals
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54 could be due to the fact that unimodal bilinguals have to switch languages in their
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4 communication, whereas bimodal bilinguals prefer to produce both the sign and the word
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6 (i.e. blend), therefore rarely switching between languages.
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9 In addition, Prior and Gollan (2011) compared the performance of a group of
10 bilinguals who regularly switch between languages with the performance of a group of
11 bilinguals who switch between languages less often. They only found an advantage on
12 non-linguistic task shifting in the bilinguals who often switch languages. Discussing Prior
13 and Gollan (2011), Paap and Greenberg (2013) cite switching as a factor but dismiss it as
14 a crucial determinant, because “... *our bilinguals overwhelmingly report that they use*
15 *both languages every day and switch every day... our bilinguals switch as often, if not*
16 *more often, than Prior and Gollan...*”. It is true that the bilinguals of Paap and Greenberg
17 probably use their two languages every day (they did not actually assess language
18 switching explicitly), and therefore once in a while must experience a language switch.
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20 This is very different however, from the amount of language switching that the Spanish-
21 English bilinguals in San Diego do. In southern California, Hispanics use Spanish and
22 English interchangeably, often multiple times within a sentence. The same occurs in
23 Catalan-Spanish speech in the bilingual population tested by Costa and colleagues (2009;
24 2008). It is unclear whether this also applies to the San Francisco population of Paap and
25 Greenberg (2013). Although their sample will certainly contain Hispanics similar to those
26 of Prior and Gollan (numbers are not provided for each language pair), it is definitely
27 more diverse, with 30 language pairs for 122 bilinguals, and for most of these languages,
28 repeated language switching may not occur in everyday conversations. As such, we
29 believe that the Paap and Greenberg (2013) study did not directly assess language
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switching and therefore it does not provide a definite answer of its importance as a determinant for the bilingual cognitive control advantage.

Finally, also Yim and Bialystok (2012) investigated the role of language switching on non-verbal and verbal task shifting performance in a group of Cantonese-English bilinguals. They only found a positive effect of language switching performance in an experimental language switching task, but no relationship between the degree of language switching and non-verbal task shifting was found, in contrast with Prior and Gollan (2011).

Above, we have summarised evidence suggesting that bilinguals develop more effective general control abilities because they must control the continuous interference between lexical representations associated with both languages, and we discussed what factor may contribute to this advantage. The primary aim of our study is to gain novel insight into the mechanisms that underlie the bilingual executive control advantage, by investigating the role of language switching experience. From a memory perspective, the interference between languages comprises competition between active lexical representations of those languages in long-term memory. As described in the memory literature (Oberauer, 2009), memory contents have the potential to cause interference when they are in an active state, but once the activation starts to decay, interference effects also rapidly disappear (Szmalec, Verbruggen, Vandierendonck, & Kemps, 2011). Therefore, we predict that the bilingual advantage originating from the competition between languages should primarily occur in bilinguals who show similarly strong activation in lexical representations of both languages at the same time, i.e. bilinguals who use both languages interchangeably within the same context (and even within the

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4 same sentence), and often switch languages. In contrast, equally proficient bilinguals who
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6 use different languages in different contexts and therefore do not switch that often, should
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8 suffer less from interference effects, so that the executive control system is less likely to
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10 develop a bilingual advantage.
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13 It is the aim of this study to investigate whether high L2 proficiency suffices for
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15 developing the bilingual control advantage, or whether a high amount of language
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17 switching experience, implying frequent simultaneous high activation in representations
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19 from both languages, is necessary. In the present study, we will therefore investigate
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21 whether a group of (Brussels) balanced bilinguals that typically switch languages *within*
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23 *discourses or sentences* show different control than regular bilinguals that do not switch
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25 that often, within the same language pair. We will compare their performance with a
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27 group of qualitatively different, but also, balanced bilinguals, and with a group of
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29 unbalanced bilinguals. Prior and Gollan (2011) already showed that bilinguals who often
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31 switch languages are better task shifters. This finding is important in the current context,
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33 but it remains unclear whether experience with language switching also interacts with
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35 bilingual advantages in tasks that share less task demands as was the case for Prior and
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37 Gollan, i.e. cognitive control tasks that imply inhibition instead of switching. Obviously,
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39 language *switching* experience is much more likely to transfer to non-verbal task *shifting*
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41 than to *inhibition*, and bilingual advantages across tasks that tap into different executive
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43 functions would suggest a more fundamental and general change to the cognitive system.
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45 Therefore, we will use two tasks that primarily measure inhibitory control, namely the
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47 flanker task and the Simon arrow task. The distinction between training tasks and training
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49 abilities is currently a major debate in the executive control literature. Some findings
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4 suggest that cognitive abilities can be trained. Jaeggi, Buschkuhl, Jonides, and Perrig
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6 (2008), for example, reported higher fluid intelligence in participants that were trained
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8 with an executive control demanding *n*-back task. Other researchers recognise several
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10 methodological concerns with such artificial training studies and claim that to this day,
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12 not one study has convincingly demonstrated that cognitive abilities can be trained, over
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14 and above (strategic) improvements in specific task demands (Shipstead, Redick, &
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16 Engle, 2010). In this view, showing that the amount of language switching by bilinguals
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18 produces an advantage for tasks with little overlap in task demands while measuring
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20 common cognitive (control) abilities, would make a strong case for this discussion in the
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22 control literature as well.
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28 The second aim of this study concerns the dissociation of language switching
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30 experience from language pair characteristics. Prior and Gollan (2011) included Spanish-
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32 English bilinguals who regularly switch between languages and Mandarin-English
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34 bilinguals who switch less often. Only the Spanish-English bilinguals showed an
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36 advantage on task switching. It was assumed that only bilinguals who often language
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38 switch train their executive control capacities, causing better performance on executive
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40 control tasks. However, these two experimental groups do not only differ in their amount
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42 of switching between languages, but also in the amount of overlap between these
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44 languages. Because languages that share orthography (in this case: English and Spanish,
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46 both alphabetic languages) and language pairs with a distinct script (English and
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48 Mandarin) require different representational structures (Gollan, Forster, & Frost, 1997)
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50 and hence also control demands, it is plausible that the bilingual advantages arising from
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52 competition between these two language pairs also differ. Indeed, task shifting research
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4 has shown that shifting between overlapping cognitive tasks (e.g., by using bivalent
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6 stimuli) causes a much greater shift cost than shifting between tasks that share fewer task
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8 features (Rogers & Monsell, 1995). Therefore, the higher shift cost for the Mandarin-
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10 English group in the Prior and Gollan study does not necessarily reflect the fact that they
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12 switch less often between languages, but may be alternatively explained by the smaller
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14 lexical overlap, between Mandarin and English. Yim and Bialystok (2012), who
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16 investigated effects of language switching performance in an experimental language
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18 switching task *within* a single population of Cantonese-English bilinguals, observed no
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20 such effect on non-verbal task shifting. Yim and Bialystok (2012), who investigated
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22 effects of language switching performance in an experimental language switching task
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24 *within* a single population of Cantonese-English bilinguals, observed no such effect on
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26 non-verbal task shifting.
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32 In summary, our aim is twofold. We intend to further disentangle the role of
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34 language switching experience for an executive function like interference resolution,
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36 while also controlling for language pair dissimilarities, including only a single language
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38 pair (unlike Prior and Gollan, 2011).
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41 We hypothesise that the general control advantage in bilingualism originates from
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43 very frequent switching between both languages, within similar contexts and within
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45 conversations. To test this hypothesis, we tested three qualitatively different groups of
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47 bilinguals: a group of unbalanced bilinguals, a group of balanced non-switching
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49 bilinguals, and a group of balanced bilinguals that do often switch languages.
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51 Importantly, the bilinguals in the three groups all master the same languages, Dutch (L1)
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53 and French (L2). We predict that the switching group will show a better performance on
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4 inhibitory control tasks compared to the unbalanced group and the non-switching group
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6 that also has high L2 proficiency. We aimed to test only one executive function (i.e.
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8 interference control), and therefore only included a flanker task and a Simon arrow task,
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10 two tasks that tap into that specific function.
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METHOD

Participants

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20 To be able to include these three different groups of bilinguals, we recruited participants
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22 in two different ways: (a) Psychology students of Ghent University, participating for
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24 credits, and (b) bilinguals that were recruited through an advertisement on the university
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26 website, and who were paid for their participation. All participants had Dutch as their L1,
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28 French as L2, and had a good knowledge of English (L3). They were all born in Belgium,
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30 highly educated, and differed in their L2 proficiency and the extent of switching. We
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32 included participants from three bilingual populations; unbalanced (UB), balanced
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34 switching (BSB), and balanced non-switching bilinguals (BnSB). The three groups all
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36 consisted of both paid and voluntary participants.
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42 Demographic participant information is shown in Table 1. All groups were
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44 matched for age, sex, and general intelligence, based on the Raven Advanced Progressive
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46 Matrices. We employed a language questionnaire (see Appendix 1) to obtain self-
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48 reported language proficiency in Dutch and French, and to assess switching behaviour.
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50 Participants rated their proficiency for listening, speaking, reading, and writing on a
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52 seven point Likert scale for every language that they had acquired (1 = very badly, 7 =
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54 very well). These measures were then averaged to create a general proficiency level.
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4 They also stated how many days per week they spoke each language The UB lived in a
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6 Dutch-dominant environment and acquired French before the age of 11 at school. After
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8 the age of 18, they hardly came in contact with the French language again. All balanced
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10 bilinguals acquired the two languages before the age of six and were highly proficient in
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12 both. As mentioned, the balanced bilinguals were divided into switchers and non-
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14 switchers. This classification was based on the information retrieved from the language
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16 questionnaire. There, the bilinguals had to indicate how often they switched between
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18 languages on a scale ranging from 0 (= never) to 7 (= very often). Balanced bilinguals
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20 with a rating of 2 or lower were referred to the non-switch group (BnSB). Balanced
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22 bilinguals with a rating of 4 or higher were assigned to the switch (BSB) group (no
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24 participant rated him/herself 3). As expected, there were no unbalanced bilinguals that
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26 switched often. Consequently, the non-switch group (BnSB) were almost never
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28 confronted (Mean = 0.9, SD = 0.7) with contexts in which language switching took place,
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30 while the switch group (BSB) regularly switched between languages within sentences
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32 and conversations (Mean = 5.8, SD = 0.9).
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Materials

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44 *Flanker task.* The stimuli were white arrows on a black background. One stimulus
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46 consisted of five arrows, participants indicated the direction of the arrow by pressing the
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48 left or the right button. The arrows could all be pointing in the same direction (congruent
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50 trials, e.g. >>>>>) or the central arrow could be pointing in the other direction than the
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52 flankers (incongruent trials, e.g. >><>>). The proportion congruent/incongruent trials
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54 was 75% - 25% (Costa et al., 2009).
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Simon arrow task. The stimuli were single white arrows on a black background. The arrows could be pointing to the right or the left, and appeared on either the left or the right side of the screen. Trials in which the direction of the arrow corresponded with the side of appearance on the screen are labelled congruent trials; trials in which the direction and the side of appearance did not correspond are incongruent trials. The proportion congruent/incongruent trials was also 75%-25% (Costa et al., 2009).

Procedure and Design

The informed consent form and language questionnaire were completed before starting the experiment. The procedure in both experiments was the following: (1) a fixation cross for 400 ms; (2) the experimental stimuli appeared until a response was given, or for maximum 1700 ms; (3) a blank screen for 1000 ms. There were 24 practice trials, followed by 3 blocks of 96 trials each. Afterwards, participants completed the Raven Advanced Progressive Matrices. We used a 2 (Congruency) x 3 (Block) x 3 (Group) design with Congruency and Block as within subjects variables and Group as a between subjects variable. The experiments were run on a standard colour monitor and were programmed and conducted using Eprime. Reaction times were measured with a Cedrus serial USB response box.

RESULTS

Demographic data.

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No significant differences were found across groups in male/female ratio, age, or intelligence (Raven) scores. Participants were asked to rate their proficiency, age of acquisition (AoA) and frequency of use of Dutch and French. There were no significant differences in general proficiency or AoA for Dutch. The UB and the BnSB used Dutch more frequently than the BSB. Significant differences between groups were found for French proficiency: the UB had significant lower L2 proficiency scores than the BnSB ($t(43)=-8.97, p<.001$) and the BSB ($t(46)=-15.50, p<.001$). Differences in general French proficiency were also found between the two balanced groups ($t(35)=-4.52, p<.001$), although L2 proficiency was also very high in the BnSB group. The French AoA of the UB differed significantly from the BnSB ($t(19.548)=20.68, p<.001$) and from the BSB ($t(22.827)=20.36, p<.001$). No differences in AoA were found between the two balanced groups ($t(35)<1$). The three groups differed significantly in frequency of use of French, with UB showing a lower frequency of use than the BnSB ($t(17,904)=-4.71, p<.001$) and the BSB ($t(46)=-18.77, p<.001$). In addition, a difference in frequency of use was found between the two balanced groups as well ($t(35)=-5.90, p<.001$). The BSB differed significantly from the BnSB ($t(34.77)=-18.78, p<.001$) and the UB ($t(46)=-25.15, p<.001$) in switching frequency.

Experiments

RTs that deviated more than 2.5 SD from the participant's mean in that task were removed (.02% of the total amount of trials). The error rate was .05%. Incorrect trials were excluded from the analyses. For both experiments we conducted an analysis of variance (ANCOVA) on RTs with Group as a categorical, between-subjects factor, and

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Congruency as within-subjects factor. Because of the difference between the groups concerning French proficiency and Frequency of use of French (L2), we included these variables as covariates². The dependent variable was the mean RT on correct trials and accuracy. In case of a significant difference across groups, we ran planned comparisons to investigate which group differed from the others. Furthermore, we calculated partial correlations, controlling for L2 proficiency, between the measure of switch frequency and reaction time performance on flanker and Simon tasks, across all bilingual groups.

Flanker task

A significant main effect of Group ($F(2,61)=5.23$, $p=.008$, $MSE=16746$) and a marginally significant effect of Congruency ($F(1,61)=3.42$, $p=.069$, $MSE=4318$) on mean RTs was found (see Figure 1). The effect of the covariate French Proficiency was not significant ($F(1,60)<1$), nor was the interaction ($F(1,60)<1$). The effect of French Frequency of use did also not reach significance ($F(1,60)<1.20$, $p=.277$). Planned comparisons show no significant differences in mean RTs between UB and BnSB ($t(43)=0.65$, $p=.517$). The BSB were faster than the BnSB ($t(35)=4.22$, $p<.001$) and than the UB ($t(46)=3.24$, $p=.002$). Analysing the data with the flanker effect as dependent variable, we found no significant interaction between Group and Congruency ($F(2,61)=2.42$, $p=.097$, $MSE=4318$) (see Figure 2). However, to further elaborate this interaction, we ran planned comparisons showing a significant difference between the UB and BSB ($t(32,266)=2.38$, $p=.023$) and between the BnSB and BSB ($t(35)=4.39$, $p<.001$). The UB and the BnSB did not differ significantly ($t(43)<1$).

² Since frequency of language switching cannot be considered as a continuous variable, we could not include it as a covariate in the analysis.

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Concerning the error rates, we only found a main effect of Congruency ($F(1,62)=65.55$, $p<.001$, $MSE=0.83$), validating the task. No other effects reached significance ($F<1$).

Simon arrow task

The ANCOVA on RTs revealed a significant main effect of Group ($F(2,61)=4.29$, $p=.018$, $MSE=6751$), and Congruency ($F(1,61)=4.10$, $p=.047$, $MSE=721$) (see Figure 3). The effect of the covariate French Proficiency was again not significant ($F(1,60)<1$), nor was the effect of French Frequency of use ($F(1,60)<1$). Planned comparisons show no significant differences in RTs between the UB and BnSB ($t(43)<1$ for congruent trials and $t(43)=-1.60$, $p=.117$ for incongruent trials), nor between the UB and BSB for congruent trials ($t(46)=1.46$, $p=.150$). For incongruent trials, we found a marginally significant difference ($t(46)=2.00$, $p=.051$). The BnSB differed significantly from BSB ($t(35)=2.05$, $p=.047$ for congruent trials and $t(35)=3.33$, $p=.002$ for incongruent trials). Analysing the data with the Simon effect as dependent variable showed a significant interaction between Group and Congruency ($F(2,61)=6.68$, $p=.002$, $MSE=721$) (Figure 4). Planned comparisons show a significant difference between the BSB and BnSB ($t(35)=3.21$, $p=.003$). The UB did not differ significantly from the BnSB ($t(43)=-1.84$, $p=.073$), nor from the BSB ($t(46)=1.54$, $p=.131$)³. French Proficiency did only marginally significantly interact with congruency ($p=.077$), implying that the slightly higher L2 proficiency of BSB cannot account for the bilingual advantage.

³ The fact that the difference between BnSB and BSB was significant, whereas the difference between the UB and the BSB was not, confirms that switching experience matters more than plain L2 proficiency. This confirms the correlations analyses in Table 2, controlling for L2 proficiency.

Language Switching and Executive Control

Partial correlations

Partial correlation analyses (see Table 2), across groups and controlling for L2 proficiency, showed that frequency of language switching was significantly correlated with the size of the congruency effects and overall RTs on incongruent trials, for both Simon and Flanker tasks. For the flanker task, the correlation for congruent trials was also significant.

DISCUSSION

The aim of this study was twofold. Firstly, we wanted to investigate the influence of language switching experience in bilinguals on a manifestation of executive control other than task switching. We therefore employed tasks tapping into interference control. Secondly, for the first time, this issue was studied by investigating language switching experience effects within a single language pair, hereby controlling for possible confounds due to language pair dissimilarities (cf. Prior & Gollan, 2011). We conducted a flanker task and a Simon arrow task, and compared the performance of unbalanced Dutch-French bilinguals, balanced bilinguals who often switch between languages in their daily lives, and bilinguals who do not often switch between languages.

The results of both tasks point largely in the same direction; balanced bilingual participants that often switch (BSB) between languages show smaller congruency effects than balanced bilinguals who do not often switch between languages (BnSB)⁴, even though these bilinguals also had very high L2 proficiency. Moreover, our measure of

⁴ In the flanker task, the BSB also showed smaller congruency effects compared to the UB, which was not the case for the Simon arrow task. This was discussed in Footnote 4.

Language Switching and Executive Control

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4 switch frequency was strongly correlated with performance on both flanker and Simon
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6 tasks, across groups and even after controlling for L2 proficiency. This suggests that an
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8 executive control advantage is only present when the lexical representations of both
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10 languages are often simultaneously active and used or inhibited during frequent language
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12 switching, e.g. in bilinguals who switch languages within conversations. The frequent
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14 simultaneous activation between strong lexical representations of different languages
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16 causes competition and necessitates the bilinguals to engage their executive control
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18 mechanism to select representations in the target language, and inhibit the non-target
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20 language. This practice then transfers not only to task switching (cf. Prior & Gollan,
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22 2011), but also to interference resolution. It is our belief that demonstrating an effect of
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24 bilingual language switching on such measure is a stronger demonstration of the fact that
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26 the bilingual advantage is a domain-general phenomenon. Demonstrating that more
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28 frequent language switchers are also better task switchers is interesting, but less
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30 surprising, and more vulnerable to circularity considerations.
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37 Additionally, we found that language switching was correlated with performance
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39 on both congruent and incongruent trials in the two tasks. Our results therefore seem to
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41 support the suggestion of Costa et al. (2009) that bilingual advantages may not only relate
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43 to conflict resolution (Bialystok et al., 2006), but generalise to overall performance
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45 (Bialystok et al., 2004; Costa et al. 2008). Costa and colleagues reasoned that the
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47 bilingual's more efficient monitoring system was at the basis of this, as bilinguals need to
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49 continuously monitor the appropriate language for each communicative interaction,
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51 depending on the interlocutor(s). Bilinguals who often find themselves in situations in
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53 which switching takes place frequently might have an even greater need to monitor the
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Language Switching and Executive Control

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4 situation. This may explain why the frequent switchers in our study performed better on
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6 the two conflict tasks, not just regarding the congruency effect, but also for overall
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8 measures.
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11 Our findings supplement the work of Prior and Gollan (2011), who showed that
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13 language and (non-verbal) task shifting was only better in bilinguals who regularly switch
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15 between languages. However, because Prior and Gollan compared switching English-
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17 *Spanish* bilinguals with non-switching English-*Mandarin* bilinguals, it was yet unclear
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19 whether the difference between these groups reflected switching experience or rather
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21 different language pair similarity. The present study clearly shows that the bilingual
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23 advantage emerges from language switching experience as groups with the same single
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25 language pair were compared. Nevertheless, given that Dutch and French are
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27 typographically similar, we do not know whether this switching effect would also
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29 generalise to a pair of typographically dissimilar languages. Yim and Bialystok (2012), for
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31 example, did not find a relation between language switching and non-verbal task shifting
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33 in Cantonese-English bilinguals. However, they did not investigate a specific group of
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35 language switching bilinguals, but instead analysed effects of a continuous measure of
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37 language switching performance in an experimental language switching task.
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44 The present findings may contribute to an explanation why findings about the
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46 bilingual executive control advantage are rather inconsistent. Whereas relatively
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48 consistent bilingual advantages have been found by Bialystok and colleagues in Canada
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50 (e.g. Bialystok, Craik, Klein, & Viswanathan, 2004; Bialystok, 2006; Bialystok & Feng,
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52 2009) and Costa and colleagues in bilingual Barcelona (e.g. Costa, Hernandez, Costa-
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54 Faidella, & Sebastian-Galles, 2009; Costa, Hernandez, & Sebastian-Gallès, 2008), a
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Language Switching and Executive Control

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4 recent study by Paap and Greenberg (2013) failed to find such evidence in any of 15
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6 executive control tasks, testing 122 bilinguals from 30 different language pairs in San
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8 Francisco. The present study suggests that active and frequent language switching may
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10 the crucial determinant for the development of the bilingual executive control advantage.
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12 Although Paap and Greenberg claim that their bilinguals switch languages daily, it is
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14 unclear whether this implies just switching languages between contexts (e.g. speaking
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16 English at university and Russian at home), or instead active and very frequent language
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18 switching within conversations, as is the case for Catalan-Spanish bilinguals⁵, or for the
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20 BSB bilinguals in Brussels from this study. Given that the large (30) number of language
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22 combinations are unlikely to be used simultaneously in San Francisco, we suspect that
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24 their bilingual population is most comparable to the BnSB from this study, which also did
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26 not show a bilingual advantage. Furthermore, it should be noted that it may also be type
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28 of switching and not simply switching frequency that plays a role in bilingual cognitive
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30 control. It seems that different types of language switching require different types of
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32 cognitive control processes (Green & Wei, 2014). This has also been suggested by Green
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34 and Abutalebi (2013) in their adaptive control hypothesis, which states that the
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36 interactional context (e.g. switching languages with different speakers vs. switching
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38 within a conversation) is important for the bilingual adaptation of cognitive control
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40 processes and to tune the networks of control.
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49 An inevitable characteristic of this study is the lack of data about monolinguals.
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51 This is a more practical issue, given that everyone in Belgium has at least knowledge of
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55 ⁵ We may speculate that the Catalan-Spanish bilinguals tested by Costa and colleagues also
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57 often switch languages, similar to the bilinguals in the present study. However, there is no
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59 quantitative data directly comparing these different bilinguals across studies.
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Language Switching and Executive Control

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4 two languages. The positive consequence of this language context is that we were able to
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6 compare different groups of bilinguals from the same language pair (Prior & Gollan,
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8 2011). We cannot, however, exclude that the unbalanced and balanced non-switching
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10 bilinguals in this study still show better performance than monolinguals. Nevertheless,
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12 note that also no differences were found between the monolinguals and the non-switching
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14 bilinguals in the Prior and Gollan study (2011).
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18 As future studies are concerned, we argue that it is advisable to include an
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20 objective measure of proficiency, such as a picture naming test in both languages, to
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22 objectify the language proficiency. In addition, because this is only the second
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24 demonstration of effects of daily language switching on cognitive control, future research
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26 may evolve towards more detailed, continuous measures of language switching (see also
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28 Yim & Bialystok, 2012), to further elaborate the role of switching frequency in the
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30 development of a control advantage. It could also be interesting to broaden these results
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32 within the same language pair, to other executive functions, such as task shifting (e.g.
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34 Prior & Gollan, 2011), although this implies more shared task demands with language
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36 switching and is therefore a weaker demonstration of a general bilingual advantage.
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42 To summarise, this study shows that language switching experience in daily life is
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44 a key determinant for the development of a stronger executive control system, underlying
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46 the alleged bilingual advantage on executive control tasks. We believe that the current
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48 demonstration of language switching experience effects demonstrates that this factor
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50 should not be neglected as a crucial determinant of the bilingual advantage, also not in
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52 further research assessing other cognitive control functions. As such, we believe that the
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Language Switching and Executive Control

current findings for interference tasks also contribute to this ongoing debate as a possible explanation for the inconsistent findings with other tasks.

For Peer Review

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References

- 1
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3
4
5
6 Abutalebi, J., & Green, D. W. (2007). Bilingual language production: The neurocognition of
7
8 language representation and control. *Journal of Neurolinguistics*, 20(3), 242–275.
9
10 doi:10.1016/j.jneuroling.2006.10.003
11
- 12 Bialystok, E., Craik, F. I. M., Grady, C., Chau, W., Ishii, R., Gunji, A., & Pantev, C. (2005).
13
14 Effect of bilingualism on cognitive control in the Simon task: evidence from MEG.
15
16 *Neuroimage*, 24(1), 40–49. doi:10.1016/j.neuroimage.2004.09.044
17
18
- 19 Bialystok, E., Craik, F. I. M., Klein, R. M., & Viswanathan, M. (2004). Bilingualism, Aging, and
20
21 Cognitive Control: Evidence From the Simon Task. *Psychology and Aging*, 19(2), 290–
22
23 303.
24
- 25 Bialystok, E., Craik, F. I. M., & Luk, G. (2008). Cognitive control and lexical access in younger
26
27 and older bilinguals. *Journal of experimental psychology. Learning, memory, and*
28
29 *cognition*, 34(4), 859–873. doi:10.1037/0278-7393.34.4.859
30
31
- 32 Bialystok, E., Craik, F. I. M., & Ryan, J. (2006). Executive Control in a Modified Antisaccade
33
34 Task: Effects of Aging and Bilingualism. *Journal of Experimental Psychology: Learning,*
35
36 *Memory, and Cognition*, 32(6), 1341–1354. doi:10.1037/0278-7393.32.6.1341
37
38
- 39 Bialystok, E., & Viswanathan, M. (2009). Components of executive control with advantages for
40
41 bilingual children in two cultures. *Cognition*, 112(3), 494–500.
42
43 doi:10.1016/j.cognition.2009.06.014
44
- 45 Botvinick, M. M., Braver, T. S., Yeung, N., Ullsperger, M., Carter, C. S., & Cohen, J. D. (2004).
46
47 Conflict monitoring: computational and empirical studies. In *The Cognitive Neuroscience*
48
49 *of Attention* (M.I. Posner.). New York: Guilford Press.
50
51
- 52 Calabria, M., Hernandez, M., Branzi, F. M., & Costa, A. (2012). Quantitative differences between
53
54 bilingual language control and executive control: evidence from task-switching. *Frontiers*
55
56 *in Psychology*, 2(339), 1–10.
57
58
59
60

Language Switching and Executive Control

- 1
2
3
4 Carlson, S. M., & Meltzoff, A. N. (2008). Bilingual experience and executive functioning in
5
6 young children. *Developmental Science*, *11*, 282–298.
7
- 8 Colzato, L. S., Bajo, M. T., Van den Wildenberg, W., Paolieri, D., Nieuwenhuis, S., La Heij, W.,
9
10 & Hommel, B. (2008). How does bilingualism improve executive control? A comparison
11
12 of active and reactive inhibition mechanisms. *Journal of Experimental Psychology:*
13
14 *Learning, Memory, and Cognition*, *34*(2). doi:10.1037/0278-7393.34.2.302
15
- 16 Costa, A., Hernandez, M., Costa-Faidella, J., & Sebastian-Galles, N. (2009). On the bilingual
17
18 advantage in conflict processing: Now you see it, now you don't. *Cognition*, *113*, 135–
19
20 149.
21
22
- 23 Costa, A., Hernandez, M., & Sebastian-Gallès, N. (2008). Bilingualism aids conflict resolution:
24
25 Evidence from the ANT task. *Cognition*, *106*(1).
26
- 27 Dove, A., Pollmann, S., Schubert, T., Wiggins, C. J., & Von Cramon, D. Y. (2000). Prefrontal
28
29 cortex activation in task switching: An event-related fMRI study. *Cognitive Brain*
30
31 *Research*, *9*(1), 103–109.
32
33
- 34 Emmorey, K., Luk, G., Pyers, J. E., & Bialystok, E. (2009). The Source of Enhanced Cognitive
35
36 Control in Bilinguals: Evidence From Bimodal Bilinguals. *Psychological Science*,
37
38 *19*(12), 1201–1206. doi:10.1111/j.1467-9280.2008.02224.x
39
- 40 Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target
41
42 letter in a nonsearch task. *Perception & Psychophysics*, *16*, 143–149.
43
44
- 45 Garbin, G., Sanjuan, A., Forn, C., Bustamante, J. C., Rodriguez-Pujadas, A., Belloch, V., ...
46
47 Avila, C. (2010). Bridging language and attention: Brain basis of the impact of
48
49 bilingualism on cognitive control. *Neuroimage*, *53*(4), 1272–1278.
50
- 51 Gollan, T. H., Forster, K. I., & Frost, R. (1997). Translation priming with different scripts:
52
53 Masked priming with cognates and noncognates in Hebrew-English bilinguals. *Journal of*
54
55 *Experimental Psychology: Learning, Memory, and Cognition*, *23*(5), 1122–1139.
56
57
58
59
60

Language Switching and Executive Control

- 1
2
3
4 Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism-*
5
6 *Language and Cognition, 1*, 67–82.
7
8 Green, D. W., & Abutalebi, J. (2013). Language control in bilinguals: The adaptive control
9
10 hypothesis. *Journal of Cognitive Psychology, 25*(5), 515–530.
11
12 Green, D. W., & Wei, L. (2014). A control process model of code-switching. *Language,*
13
14 *Cognition and Neuroscience, 29*(4), 499–511.
15
16 Grosjean, F. (1989). Neurolinguists, beware! The bilingual is not two monolinguals in one
17
18 person. *Brain and Language, 36*(1), 3–15.
19
20 Hermans, D., Bongaerts, T., De Bot, K., & Schreuder, R. (1999). Producing words in a foreign
21
22 language: Can speakers prevent interference from their first language? *Bilingualism-*
23
24 *Language and Cognition, 1*, 213–229.
25
26 Hernandez, A. E., Dapretto, M., Mazziotta, J., & Bookheimer, S. (2001). Language switching and
27
28 language representation in Spanish-English bilinguals: An fMRI study. *Neuroimage,*
29
30 *14*(2), 510–520.
31
32
33
34 Hernández, M., Martin, C. D., Barceló, F., & Costa, A. (2013). Where is the bilingual advantage
35
36 in task-switching? *Journal of Memory and Language, 69* (3), 257-276.
37
38 Hernandez, A. E., Martinez, A., & Kohnert, K. (2000). In search of the language switch: An
39
40 fMRI study of picture naming in Spanish-English bilinguals. *Brain and Language, 73*(3),
41
42 421–431. doi:10.1006/brln.1999.2278
43
44
45 Jaeggi, S. M., Buschkuhl, M., Jonides, J., & Perrig, W. J. (2008). Improving fluid intelligence
46
47 with training on working memory. *Proceedings of the National Academy of Sciences of*
48
49 *the United States of America, 105*(19), 6829–6833.
50
51
52 Lagrou, E., Hartsuiker, R. J., & Duyck, W. (2011). Knowledge of a second language influences
53
54 auditory word recognition in the native language. *Journal of Experimental Psychology:*
55
56
57
58
59
60

Language Switching and Executive Control

- 1
2
3
4 Learning, Memory, and Cognition. *Journal of Experimental Psychology: Learning,*
5
6 *Memory, and Cognition*, 37, 952–965.
7
- 8 Martin-Rhee, M. M., & Bialystok, E. (2008). The development of two types of inhibitory control
9
10 in monolingual and bilingual children. *Bilingualism, Language, and Cognition*, 11(1).
11
12 doi:10.1017/S1366728907003227
13
- 14 Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D.
15
16 (2000). The unity and diversity of executive functions and their contributions to complex
17
18 “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, 41(1), 49–100.
19
- 20 Oberauer, K. (2009). Interference between storage and processing in working memory: Feature
21
22 overwriting, not similarity-based competition. *Memory & Cognition*, 37(3), 346–357.
23
- 24 Paap, K. R., & Greenberg, Z. I. (2013). There is no coherent evidence for a bilingual advantage in
25
26 executive processing. *Cognitive Psychology*, 66, 232–258.
27
- 28 Prior, A., & Gollan, T. H. (2011). Good language-switchers are good task-switchers: Evidence
29
30 from Spanish-English and Mandarin-English bilinguals. *Journal of the International*
31
32 *Neuropsychological Society*, 17, 1–10.
33
- 34 Prior, A., & MacWhinney, B. (2010). A bilingual advantage in task switching. *Bilingualism-*
35
36 *Language and Cognition*, 13, 253–262.
37
- 38 Rogers, R. D., & Monsell, S. (1995). Costs of a predictable switch between simple cognitive
39
40 tasks. *Journal of Experimental Psychology: General*, 124(2), 207–231.
41
- 42 Shipstead, Z., Redick, T. S., & Engle, R. W. (2010). Does working memory training generalize?
43
44 *Psychologica Belgica*, 50(3-4), 245–276.
45
- 46 Szmalec, A., Verbruggen, F., Vandierendonck, A., & Kemps, E. (2011). Control of Interference
47
48 During Working Memory Updating. *Journal of Experimental Psychology: Human*
49
50 *Perception and Performance*, 37(1), 137–151.
51
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Language Switching and Executive Control

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2
3
4 Van Assche, E., Duyck, W., Hartsuiker, R. J., & Diependaele, K. (2009). Does Bilingualism
5
6 Change Native-Language Reading? Cognate Effects in a Sentence Context.

7
8 *Psychological Science*, 20(8), 923–927.

9
10 Wager, T. D., Jonides, J., & Smith, E. E. (2006). Individual differences in multiple types of
11
12 shifting attention. *Memory & Cognition*, 34, 1730–1743.

13
14 Wager, T. D., Jonides, J., Smith, E. E., & Nichols, T. E. (2005). Toward a taxonomy of attention
15
16 shifting: Individual differences in fMRI during multiple shift types. *Cognitive, Affective*
17
18 *& Behavioral Neuroscience*, 5, 127–143.
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Table 1. Self-reported data and scores on Raven's Matrices by group.

| | Unbalanced bilinguals (UB) | Balanced non-switching bilinguals (BnSB) | Balanced switching bilinguals (BSB) |
|--|-------------------------------|---|--|
| N | 28 | 17 | 20 |
| Male/female ratio | 9/19 | 3/14 | 4/17 |
| Age (years) | 20.7 (1.7) | 20.9 (3.4) | 21.7 (6.1) |
| Raven's Matrices (score on 12 items) | 11.0 (1.0) | 10.8 (1.4) | 10.8 (1.3) |
| Computer games (days/week) | 2.3 (1.8) | 1.9 (0.8) | 2.0 (1.7) |
| Dutch (L1) (self-report scale) ¹ | 7.0 (0.0) | 7.0 (0.0) | 7.0 (0.0) |
| Age of acquisition | 0.0 (0.0) | 0.0 (0.0) | 0.0 (0.0) |
| Frequency of use (days/week) ² | 7 (0.0) | 7 (0.0) | 6.8 (0.5) |
| French (L2) (self-report scale) ¹ | 2.7 (0.9) | 5.2 (0.8) | 6.3 (0.8) |
| Age of acquisition | 10.2 (0.7) | 1.2 (1.7) | 0.9 (1.9) |
| Frequency of use (days/week) ² | 0.6 (0.6) | 3.0 (2.0) | 6.2 (1.7) |
| Frequency of switching ³ | 0.5 (0.6) | 0.9 (0.7) | 5.8 (0.9) |

¹ L1 and L2 proficiency was indicated on a 7-point Likert scale, ranging from 1 (= very bad) to 7 (= very good).

² Participants reported how many days per week they spoke Dutch and French.

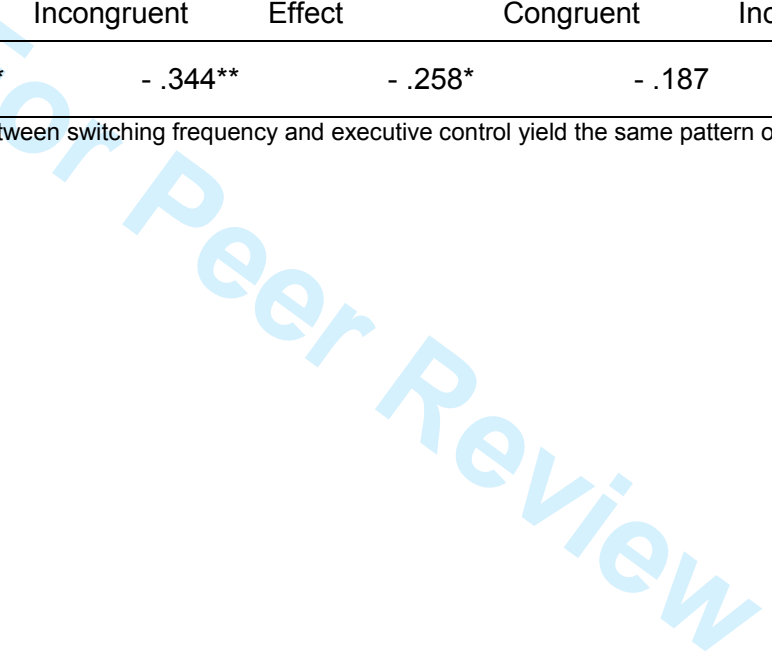
³ Frequency of switching was indicated on an 8-point Likert scale, ranging from 0 (= never) to 7 (= very often).

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Table 2. Partial correlations, controlling for L2 proficiency, between switch frequency and measures of executive control (flanker and Simon tasks) across the three groups. ** = $p < .01$, * = $p < .05$.¹

| | Flanker | | | Simon | | |
|------------------|-----------|-------------|--------|-----------|-------------|---------|
| | Congruent | Incongruent | Effect | Congruent | Incongruent | Effect |
| Switch frequency | -.388** | -.344** | -.258* | -.187 | -.354** | -.388** |

¹ Non-parametric Spearman correlations between switching frequency and executive control yield the same pattern of significant correlations.



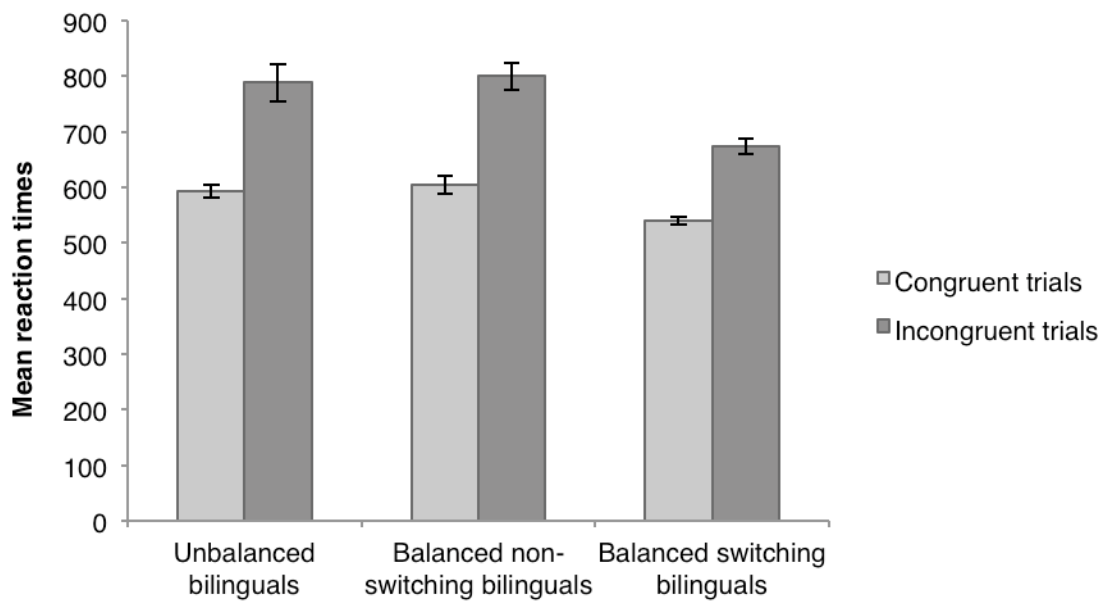


Figure 1. Reaction times by congruency (congruent vs. incongruent) in the flanker task (bars represent standard errors).

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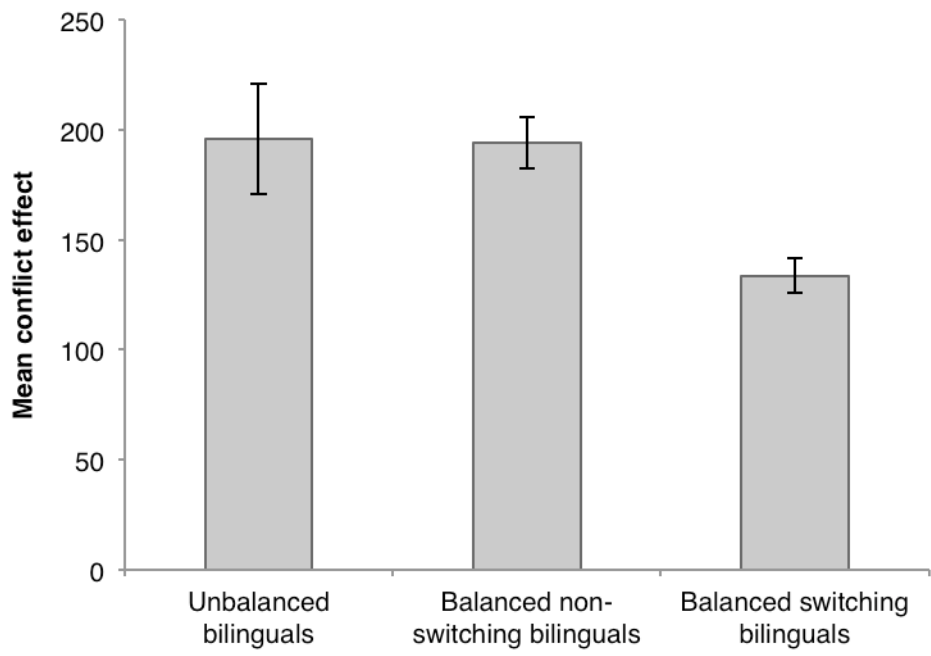


Figure 2. Size of the congruency effect in the Flanker task by groups (bars represent standard errors).

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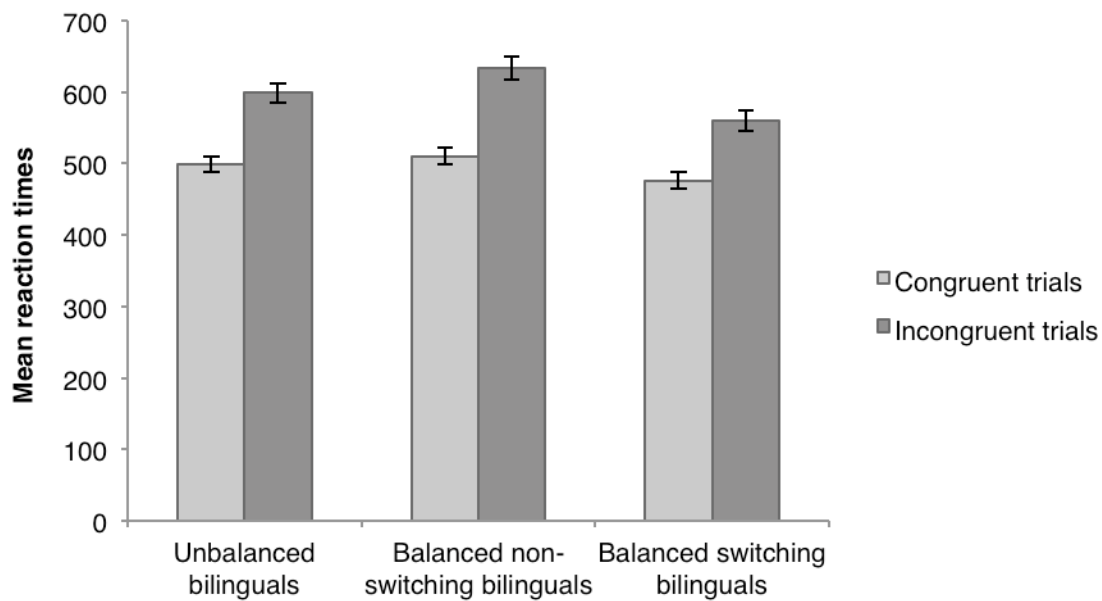


Figure 3. Reaction times by congruency (congruent vs. incongruent) in the Simon Arrow task (bars represent standard errors).

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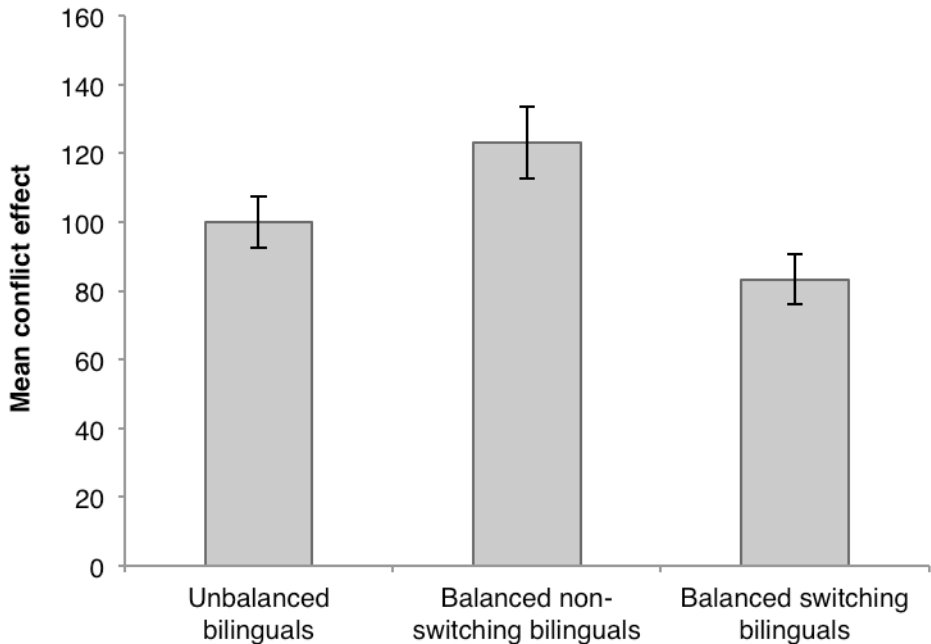


Figure 4. Size of the congruency effect in the Simon Arrow task by group (bars represent standard errors).

Peer Review

LANGUAGE PROFICIENCY QUESTIONNAIRE

(translated from the Dutch original)

Name:

Sex:

Date of birth:

Do you master multiple languages? Can you rank them?

(1. language in which you are most proficient)

- 1.
- 2.
- 3.
- 4.

Language 1 (L1)

1. At what age did you acquire the language?
2. How many days a week do you use this language?
3. In which particular context and for which specific purposes do you use this language?
4. Try to assess your skills in using this language:

| | Very badly | | | | | | Very well |
|------------------|---------------|---|---|---|---|---|--------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Listening | | | | | | | |
| Speaking | | | | | | | |
| Reading | | | | | | | |
| Writing | | | | | | | |

Remarks:

Language 2 (L2)

1. At what age did you acquire the language?
2. How many days a week do you use this language?

- 1
2
3
4
5
6
7
3. In which particular context and for which specific purposes do you use this language?
 4. Try to assess your skills in using this language:

8
9
10
11
12
13
14
15
16

| | Very badly | | | | | | Very well |
|------------------|------------|---|---|---|---|---|-----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Listening | | | | | | | |
| Speaking | | | | | | | |
| Reading | | | | | | | |
| Writing | | | | | | | |

17
18
19
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Remarks:

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| |
|------------------------|
| Language 3 (L3) |
|------------------------|

- 27
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1. At what age did you acquire the language?
 2. How many days a week do you use this language?
 3. In which particular context and for which specific purposes do you use this language?
 4. Try to assess your skills in using this language:

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| | Very badly | | | | | | Very well |
|------------------|------------|---|---|---|---|---|-----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Listening | | | | | | | |
| Speaking | | | | | | | |
| Reading | | | | | | | |
| Writing | | | | | | | |

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49
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Remarks:

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| |
|------------------------|
| Language 4 (L4) |
|------------------------|

1. At what age did you acquire the language?

2. How many days a week do you use this language?
3. In which particular context and for which specific purposes do you use this language?
4. Try to assess your skills in using this language:

| | | | | | | | |
|------------------|------------|---|---|---|---|---|-----------|
| | Very badly | | | | | | Very well |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Listening | | | | | | | |
| Speaking | | | | | | | |
| Reading | | | | | | | |
| Writing | | | | | | | |

Remarks:

Additional question:

How often are you in a situation in which you switch between languages?

| | | | | | | | |
|-------|---|---|---|---|---|---|------------|
| Never | | | | | | | Very often |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Remarks:

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