Can we find a processing advantage for bilingual 3rd-graders in Germany?

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Background
Bilingual students in Germany have less success in school than their monolingual peers (Chudáček, 2011).
Possible reasons:
• Lower socio-economic status (SES)
• Smaller mental lexicon in German
important predictor e.g. for reading
skills (Unland et al., 2014)

Bilingualism supposedly improves executive functions (EF), because coordinating two languages trains general executive functions
• Most studies were conducted in Canada (47% in the meta-analysis by Adesope et al., 2010)
• Evidence for improved inhibition (Martin-Rhee & Bialystok, 2008; Paap & van Heij, 2012), monitoring (Singh & Maitra, 2013), task-switching (Prior & MacFerron, 2009)
But doubt about the existence of the processing advantage and criticism on study designs increases
• Publication bias for positive results (de Bruin et al., 2014)
• Positive findings could sometimes not be replicated (Paap & Sow, 2014)
• Too small sample size and uncontrolled confounding factors (e.g. SES, lexicon size, migration status) can distort results (Peep & Savijoki, 2014)
• Advantage only in conditions with high cognitive demands (Costa et al., 2006)

Method

<table>
<thead>
<tr>
<th>Monolinguals</th>
<th>Bilinguals</th>
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<tbody>
<tr>
<td>N / female</td>
<td>78 / 43</td>
</tr>
<tr>
<td>Age: months</td>
<td>108 (5)</td>
</tr>
<tr>
<td>Intelligence¹</td>
<td>35.2 (6.7)</td>
</tr>
<tr>
<td>Expressive Lexicon ²</td>
<td>25.1 (6.2)</td>
</tr>
<tr>
<td>SES: family net income ³</td>
<td>7.3 (3.0)</td>
</tr>
<tr>
<td>SES: BCED mother</td>
<td>3.7 (1.0)</td>
</tr>
<tr>
<td>Proficiency German ⁴</td>
<td>3.8 (0.4)</td>
</tr>
<tr>
<td>Proficiency Other language ⁵</td>
<td>2.9 (0.8)</td>
</tr>
<tr>
<td>Age of acquisition German / ⁶</td>
<td>31.1 (29.5) /</td>
</tr>
</tbody>
</table>


Results

Linear mixed model
• With complete datasets
• Reaction times are log-transformed
• Covariates GENDER and INTELLIGENCE

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<tr>
<th>Go/Nogo</th>
<th>N-back</th>
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| Task: Respond with button press on blue field (to one stimulus, while suppressing response to another).
Items were pseudo-randomized and presented in 2 blocks with 20 items each. | Task: Single letters are presented successively on tablet. Answer with button press when current letter is the same as one (1-back) or two trials (2-back) before. Increased distance increases demands on working memory/monitoring. |

Discussion

In accordance with other studies, we found substantial differences between language groups:
• Bilinguals have lower SES, smaller lexicon and lower self-rated language proficiency in German

Processing advantage
We could not find a significant advantage for the bilingual group, in contrast to findings from Canada.

Disadvantage in Go/Nogo
• Disadvantaged position (SES, lexicon etc.) of bilinguals might be reflected in lower RTs → difference remains despite covariates

N-back
When GENDER and INTELLIGENCE are included in linear model, group differences disappear
• Increasing WM-demands seem to influence bilinguals less severely than monolinguals → could indicate an advantage in WM, considering that they perform more slowly in general (Go/Nogo and N-back)

Tendency to advantage in BST
• No significant group differences but tendency that bilinguals answer faster
• Bilinguals might be able to compensate differences (SES, vocabulary etc.) to monolingual peers that interfere with their performance in N-back and Go/Nogo
• Might indicate an advantage in interference inhibition
• In accordance with studies that find superior performance of bilinguals in tasks with high demands on interference inhibition, but not in tasks of other EF-components (Martin-Rhee & Bialystok, 2008; Esposito, 2013)

Influencing factors
Intelligence positively influences performance in all tasks (marginally significant effects in N-back and BST)
• High WM and monitoring demand in N-back both are related to intelligence (Alloway & Alloway, 2010; Diamond, 2013)
• Gender
• Girls answer more slowly than boys in the BST.

Future directions
Are there variables that influence the performance of bilinguals and monolinguals differently?
• E.g. Does vocabulary size influence bilinguals, but not monolinguals → To reduce the influence of confounding variables, we will calculate separate models for each group. This allows us to include SES, vocabulary and age as those variables in which the language groups differ. 

References
CFT – Measure of working memory (WM) or monitoring
Go/Nogo
Task: Respond with button press on blue field (to one stimulus, while suppressing response to another).
Items were pseudo-randomized and presented in 2 blocks with 20 items each.
N-back
Task: Single letters are presented successively on tablet. Answer with button press when current letter is the same as one (1-back) or two trials (2-back) before. Increased distance increases demands on working memory/monitoring.
BST
Task: Sort shapes while ignoring their color
Incongruity between item and button increases inhibition demands.
First homogeneous blocks were completed with only congruent or incongruent items, and afterwards a mixed block with randomized items of all congruency conditions.

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