Examining the Bilingual Advantage on Conflict Resolution Tasks: A Meta-Analysis

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ABSTRACT

A great deal of research has compared monolingual and bilinguals on conflict resolution tasks, with inconsistent findings: Some studies reveal a bilingual advantage on global RTs, some reveal a bilingual advantage on interference cost, and some show no advantage. We report a meta-analysis of 73 comparisons (N = 5538), with estimates of global RTs and interference cost for each study. Results revealed a moderately significant effect size that was not moderated by DV (global RT or interference cost) or task. Age interacted with type of cost, showing a pattern difficult to reconcile with theories of bilingualism and executive control. Additionally there was a significant main effect of lab, which might be due to sociolinguistic differences in samples, data treatment or differences in methodology.

INTRODUCTION

Bilingual advantages have been reported on both Global RTs and Interference Costs, on many conflict resolution tasks (e.g. Simon, Flanker, Stroop task) (Bialystok et al 2009).

However, both of these findings have been difficult to replicate (Paap & Greenberg, 2013).

This may be because of variation in tasks, participant age and the methods used by particular labs.

Moreover, if the advantages conferred by bilingualism compete with those conferred by other habits, these may be difficult to observe in single studies (Valian, 2015).

One promising approach is meta-analysis:
- We can combine a large number of separate samples.
- Systematically test the impact of potential moderators.

METHOD

Literature Search:
- PsychINFO and other databases searched periodically until Januarary, 2015.
- All studies include at least one bilingual group, at least one monolingual group, participants without psychological impairment, and RT measures for conflict resolution tasks.
- A total of 39 studies, containing 73 comparisons (see below), and 5538 participants.

Effect Size calculation:
- Cohen's *d's* were calculated for Global RT and Interference Cost at the level of *comparison*.
  - One monolingual and one bilingual group on the first block of a single task.
  - This assumes tasks within studies are not correlated (Paap & Sawi, 2014).
  - Also assumes no dependence among different groups of participants within a single study.
- In cases where no SDs or SEs were available, SDs were imputed using a linear regression of SD from M.
- When *SD*s of Interference Costs were not available, they were estimated using imputed correlations between congruent and incongruent trials.

Moderators:
- DV – Global RT or Interference Cost
- Task – Simon, Flanker, Stroop, Other
- Age – Children, Young Adult, Older Adult
- Lab – 5 dummy coded variables for corresponding author on four or more comparisons.

Analysis:
- Forest plots estimated using the *metafor* package in *R* (Viechtbaur, 2010).
- Three-level meta-analysis fit using the *metasem* package in R (Cheung, 2014).

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STATISTICAL MODELS

Because Global RTs and Interference Costs are correlated, three-level meta-analysis was conducted (Cheung, 2014):

Random Effects Meta-Analysis

$$y_i = \beta_0 + \beta_1 x_i + u_i + e_i$$

Variation in Effect Size Distribution; Sampling Error

Three-Level Meta-Analysis

$$y_i = \beta_0 + \beta_1 x_i + u_{(2)ij} + u_{(3)ij} + e_{ij}$$

Variation within cluster; Variation in Effect Size Distribution; Sampling Error

Model 1: Null Model, no moderators

Model 2: Model with DV (Interference Cost/Global RT) as a moderator

Models 3 – 8: For each additional moderator, one main effect model and one model with interaction of the moderator and DV. Each compared to Model 1 and Model 2.

RESULTS

Forest plots for effect sizes for Global RTs and Interference Costs, separately.

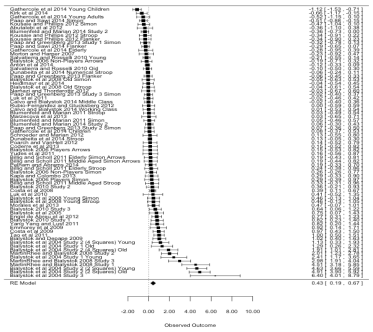

Figure 1: Global RTs

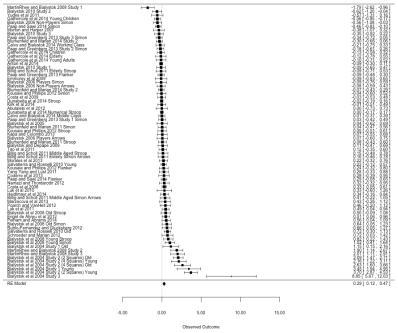

Figure 2: Interference Costs

Model 1: Overall significant effect size with significant heterogeneity, d = .39, CI = .19 - .59, Q (145) = 886.918, p < .001

Model 2: Including DV into the model did not significantly improve fit, according to likelihood ratio test, p = .52.

Models 3 – 8: In Table below:

Model	R^2 within	R^2 between	P-value (vs Null)	P-Value (vs DV only)
DV + Task	.00	.05	.60	.53
DV * Task	.07	.04	.46	.43
DV + Age	.00	.00	.75	.74
DV * Age	.26	.00	.04	.02
DV + Lab	.00	.36	<.001	<.001
DV * Lab	.26	.36	<.001	<.001

Amongst older adults, significantly larger effect sizes for Interference cost than Global RTs (B = .47, Z = 3.31, p < .001)

Interaction model did not fit significantly better than additive model, p = .09

DISCUSSION

The overall effect size was moderately large and significantly different than 0. However, this study only considered published literature and may be subject to publication bias (de Bruin et al 2014).

Surprisingly, DV did not moderate effect size in the published literature. However, there was an interaction between DV and age, indicating significantly larger effect sizes for Interference Costs than Global RTs for older adults, and marginally significantly larger effect sizes for Global RTs than interference costs for older adults. This effect is difficult to interpret, but could possibly be caused by modeling interference costs as additive rather than multiplicative effects.

The lab effect was large and highly significant. This could reflect differences in subject pools, or methodological factors, such as methods for handling outliers.

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