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INTRODUCTION

It has been hypothesized that bilinguals show better inhibitory control (IC) than monolinguals (Bialystok, 1999). However, this advantage has not been consistently found. In the literature, tasks that do not necessarily assess the same IC function have been used to measure IC as a whole, and might have led to inconsistent findings.

Main Research Question of Current Review

Do bilinguals show an advantage in all IC functions or only in those closely related to IC in speech production?

Inhibitory Control in Bilinguals

Green (1998)

- Language = communicative *action* via the supervisory attentional system (SAS)
- 1. Schema level inhibition
- 2. Word selection at the lemma level

Bialystok (1999)

- Bilinguals have more practice, and thus a bilingual advantage in IC

Distinct Functions of IC

Friedman & Miyake (2004)

- Prepotent response inhibition:**
Ability to withhold dominant responses
- Resistance to distractor interference:**
Ability to resist irrelevant information
- Resistance to proactive interference (PI):**
Ability to resist memory intrusions from information that was once relevant

Hypotheses of the Current Review

- Bilingual advantage would appear predominantly in tasks related to *resistant to distractor interference* and *prepotent response inhibition*.
- Advantage in prepotent response tasks would be found more consistently in *unbalanced bilinguals* than balanced bilinguals.

METHOD

Inclusion Criteria:

- Peer-reviewed, empirical studies in English
- Included healthy participants with no psychiatric/neurological disorders
- Behavioural findings comparing bilinguals vs. monolinguals / balanced vs. unbalanced bilinguals

Exclusion Criteria:

- Tasks related to switching of languages
- Tasks that assess more than one IC function
- Only included bimodal bilinguals
- Only reported neuroimaging data

Literature Search:

- Keywords: bilingual, bilingualism, inhibition, interference, suppression, inhibitory control, attentional control, cognitive control

Coding:

- Categorized tasks & articles accordingly to Friedman & Miyake's (2004) definitions
- Dependent variables: RT, accuracy, error rates, or performance cost that indicate IC abilities
- Other factors (when available): n, age, sex, linguistic characteristics, SES variables, performance on other cognitive measures

Key References:

Bialystok, E. (1999). Cognitive complexity and attentional control in the bilingual mind. *Child Development*, 70(3), 636-644.

Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition*, 1, 67-81.

Friedman, N. P. & Miyake, A. (2004). The relations among inhibition and interference control functions: A latent-variable analysis. *Journal of Experimental Psychology: General*, 133(1), 101-135.

Hilchey, M. D. & Klein, R. M. (2011). Are there bilingual advantages on nonlinguistic interference tasks? Implications for the plasticity of executive control processes. *Psychonomic Bulletin & Review*, 18, 625-658.

RESULTS & DISCUSSION

- 37 studies were selected for this review

The Bilingual Advantage in Different Functions of IC

Table 1. Summary of Previous Findings on Individual IC Functions.

Tasks	Bilingual Advantage?	# Sig. Comparisons/ Total # Comparisons
Prepotent Response Inhibition (25 Articles)		
The Simon task • Variants: arrow version and complex version	Yes • Only in middle-aged and older adults	7 / 24 (11 studies)
The Stroop task • Variants: numerical version, Shape Stroop, bivalent shape task	Yes • Across age groups • Exception: Colour-naming Stroop with 4 colours	6 / 9 (7 studies)
Antisaccade task • Face task	Yes • Only in children and older adults	2 / 6 (3 studies)
Opposite tasks^a • Opposite worlds task, Luria's tapping task, Stroop picture naming task, reverse categorization, Day/Night task	Yes • Only found with opposite worlds task, Luria's tapping task, and reverse categorization task • Findings sensitive to task difficulty and age of SS	7 / 11 (5 studies)
Response inhibition tasks • Stop signal, go/no-go, Simon Says, sustained attention response task (SART)	No	0 / 10 (6 studies)
Summary:	<ul style="list-style-type: none"> Bilinguals of all ages show advantage in prepotent IC at the stimulus level (Stroop) Effect at the response level may only appear in children & older adults whose IC is poorer No bilingual advantage in response inhibition – this function is not practiced in bilingual speech production 	
Resistance to Distractor Interference (18 Articles)		
The Flanker task^b (28/15) • Variants: The Eriksen Flanker task, attentional network task (ANT), the lateralized ANT (LANT)	Yes • Only in young adults; sensitive to number of trials (bilingual adapt to the task faster than monolinguals) • No effect in children (might have higher response variability & lower adaptability) • Insufficient data for older adults	7 / 28 (15 studies)
Search tasks^a (3/3) • Embedded Figures task, Sky Search task	Yes • Only found with Sky Search task • SS older (8 y/o) than in the other studies (5-6 y/o)	1 / 3 (3 studies)
Forced-attention dichotic listening task^c	Yes • Might be due to better phoneme distinction	2 / 2 (1 study)
Summary:	<ul style="list-style-type: none"> Bilingual effect was most evident in young adults; limited evidence for an advantage in children Few studies on older adults 	
Resistance to Proactive Interference (2 Articles)		
Visually cued recall task^a	No	0 / 2 (1 study)
Proactive interference (PI) task^b	Yes • Only in children	1 / 2 (1 study)
Summary:	<ul style="list-style-type: none"> Few studies on resistance to PI (none with older adults) Overall bilingual effect was not robust in young adults and children 	

Note: ^a Only administered to children. ^b Not administered to older adults. ^c Only administered to middle-aged and older adults.

Comparison of Balanced and Unbalanced Bilinguals in Prepotent Response Inhibition

- Above bilingual advantage (or lack of an effect) in prepotent response tasks was not sensitive to SS' language proficiency
- Direct comparisons between balanced and unbalanced bilinguals either yielded no difference between the two groups (Simon task; Salvatierra & Rosselli, 2010) or better performance in balanced bilinguals (Stroop; Kharkhurin, 2011)
- There is no evidence that unbalanced bilinguals show more benefits in prepotent response inhibition than balanced bilinguals

CONCLUSIONS & SUGGESTIONS FOR FUTURE RESEARCH

Conclusion:

- The bilingual advantage in IC was most extensively studied in prepotent response and distractor interference tasks. The effect was found in both tasks, and appears to be mediated by age. The effect in distractor interference tasks was shown mostly in young adults, whereas the effect in prepotent response tasks was more common in children and middle-aged and older adults.
- Research on bilinguals' IC in PI tasks was limited; from existing research, there is little evidence supporting a bilingual advantage in this function. More research in PI tasks is needed to reach a stronger conclusion.
- Unbalanced bilinguals' need to suppress a dominant language does not lead to a better prepotent response inhibition function than balanced bilinguals.

Limitations of Current Findings and Suggestions for Future Research:

- Some inhibition tasks (e.g., colour-naming Stroop task in Kousaie & Phillips, 2012) involve other non-inhibition cognitive functions (e.g., working memory; the "impurity problem", Friedman & Miyake, 2004).
- It is important to distinguish between overall conflict monitoring abilities (Hilchey & Klein, 2011), facilitation, and IC.
- Bilingual experiences were assessed differently across studies (e.g., age of L2 acquisition, length of exposure to L2, proficiency of the two languages). If the advantage in general IC is due to bilinguals' lifelong practice in inhibiting the irrelevant language, then it is critical to assess the *amount* of inhibition in SS' daily speech production.

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