The effect of taxing inhibitory control on bilingual language switching: Evidence from dual-task paradigms

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Abstract

Bilinguals may manage competition between their languages by relying on domain-general inhibitory control (the IC model; Green, 1998). However, evidence for this model is mostly indirect. These experiments investigated the role of domain-general IC in bilingual lexical access by experimentally manipulating demand on IC during a language switching task. If bilinguals rely on domain-general IC to switch between languages, then concurrent demands on IC should make switching especially difficult. Surprisingly, Experiments 1 and 2 found that language switching was *less* costly when IC was taxed, whether by visuospatial or verbal IC demands. Experiment 3 showed that this reduction in switch costs was not attributable to *conflict adaptation* between an IC demanding task and language switching. These findings thus fail to support a straightforward role of IC in bilingual language switching and suggest that language control, at least in the context of language-switching tasks, may not draw on domain-general IC.

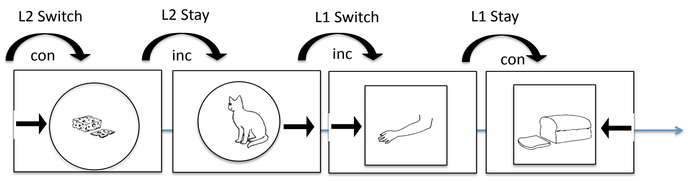
Background

- Bilingual language production is typically considered a competitive process (e.g. Costa, et al.,1999; Kroll et al., 2006)
- The Inhibitory Control (IC) model (Green, 1998) suggests bilinguals rely on inhibitory control to manage their languages. Support for IC model comes from:
  - Asymmetrical language switch costs (e.g., Meuter & Allport, 1999)
    - …but controversial (e.g., Monsell et al, 2003; Finkbeiner et al., 2006, Yeung & Monsell, 2003)
  - Correlations between domain-general inhibitory control abilities and language switch costs (e.g. Linck et al, 2012)
    - …but correlations might reflect other factors (education, SES, etc.)
  - Bilingual "advantage" in domain-general inhibitory control tasks (e.g. Bialystok, 1999; Abutalebi et al., 2012)
    - …but inconsistent findings, which may suffer from publication bias (e.g. de Bruin et al., 2014; Papp and Greenberg, 2013)

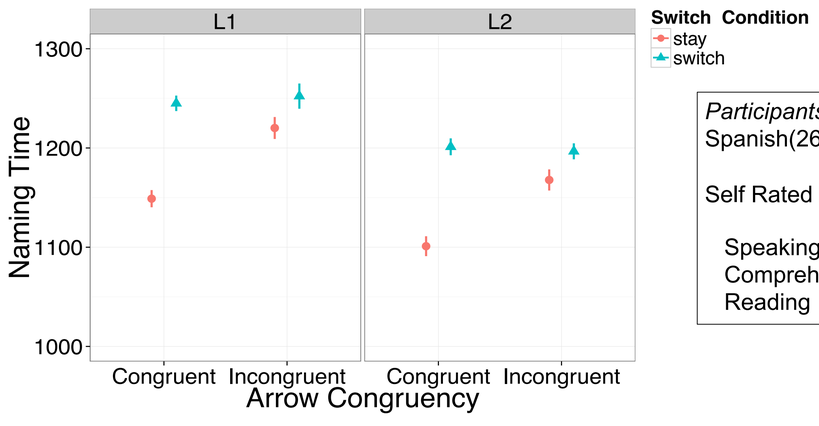
The current experiments test the role of IC in bilingual language switching by manipulating demand on domain-general IC during a language switching task.

Experiment 1

- Language switch task paired with visuospatial *Simon Stroop* task (Simon, 1969)
  - *Task 1:* name pictures in alternating runs of L1/L2
  - *Task 2:* indicate arrow direction while ignoring arrow location



- If language switching relies on domain-general IC as taxed by Simon task, switching costs should be exacerbated during incongruent arrow trials.
- If language switching and Simon task do *not* rely on shared IC resources, switching and Simon effects should be independent.

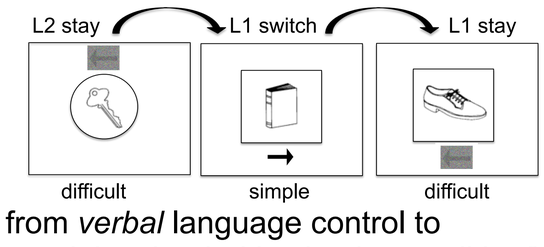


Participants: 37 advanced L2 Learners of Spanish(26), French (10), Japanese(1)

Self Rated L2 Proficiency (LEAP-Q):

	M	*SD*
Speaking	6.91	1.70
Comprehension	7.13	1.58
Reading	7.52	0.99

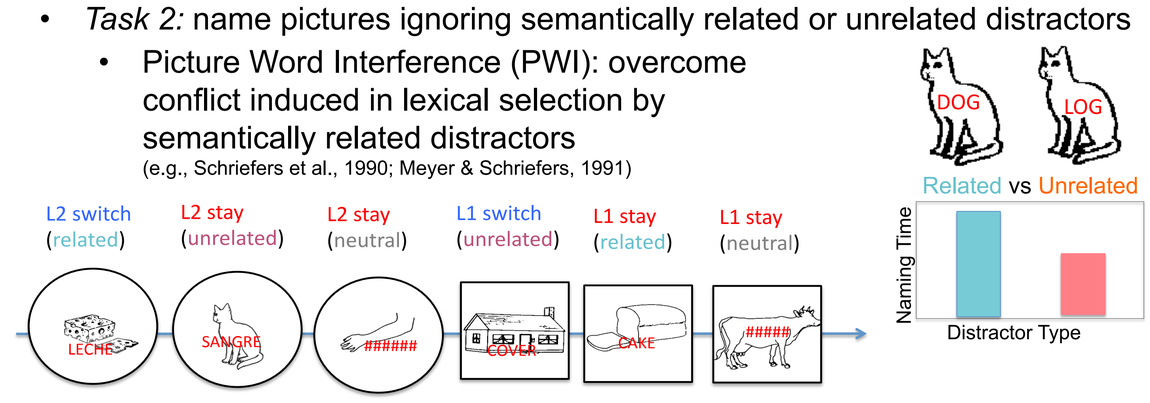
- Surprisingly, switching costs were significantly *smaller* during incongruent compared to congruent Simon trials (a switch by congruency interaction: b = -0.05, SE = 0.02, t = -2.24)
- No interaction in control experiment using a secondary task with perceptually difficult but not IC-demanding, arrows.



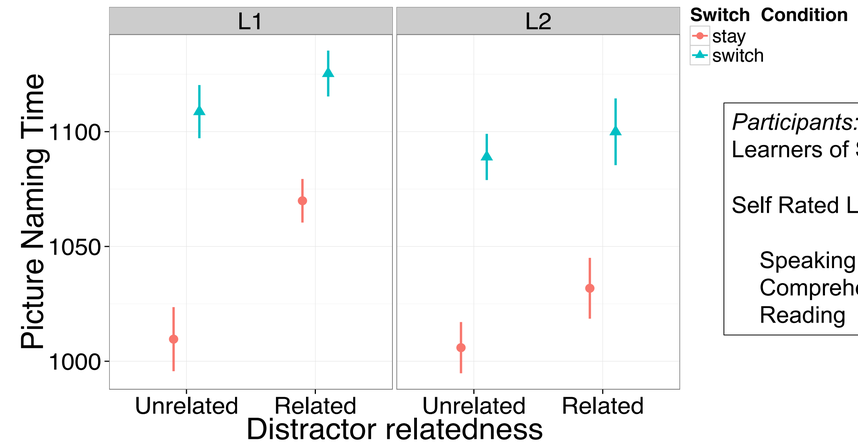
- Is *spatial* Simon arrow conflict too distinct from *verbal* language control to interfere? And/or do these data reflect differential task prioritization by condition?

Experiment 2

- Language switch task paired with verbal *picture word interference* (PWI) task
  - *Task 1:* name pictures in alternating runs of L1/L2
  - *Task 2:* name pictures ignoring semantically related or unrelated distractors
    - Picture Word Interference (PWI): overcome conflict induced in lexical selection by semantically related distractors (e.g., Schriefers et al., 1990; Meyer & Schriefers, 1991)



- If language switching relies on domain-general *verbal* IC as taxed by PWI task, switching costs should be exacerbated during semantic competitors.
- If language switching and PWI do not rely on shared IC resources, switching and PWI effects should be independent.



Participants: 32 advanced L2 Learners of Spanish

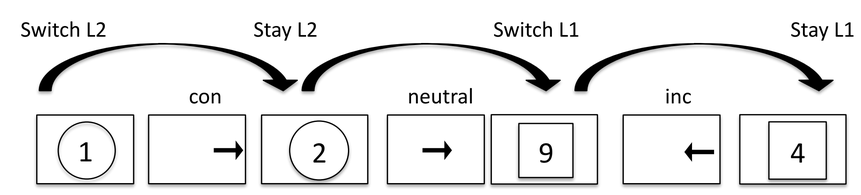
Self Rated L2 Proficiency (LEAP-Q):

	M	*SD*
Speaking	6.48	1.50
Comprehension	7.55	1.56
Reading	7.34	1.22

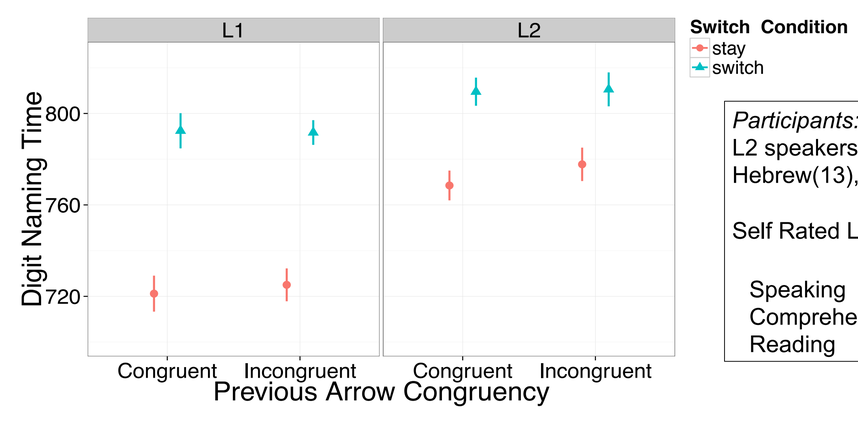
- Similar to Experiment 1, switch costs were significantly *smaller* during semantic interference trials (a switch by relatedness interaction; b = 0.027, SE = 0.013, t = -2.18)
- …despite concurrent *verbal* IC demands and only one task (so not due to differential task prioritization)

Experiment 3

- Do these *under-additive* interactions between language switching and IC demanding tasks in Exps 1 and 2 still show shared reliance on IC?
  - Test with *conflict adaptation* (CA) paradigm: reduced cost of conflict following conflict vs. non-conflict trials (Botvinick, 2001; Gratton et al., 1992)
  - As CA can occur between linguistic and non-linguistic tasks (Kan et al., 2013), Experiment 3 alternated language switching and Simon arrow tasks



- If these results reflect conflict adaptation, switching costs should be reduced following conflict (compared to non-conflict) arrow trials.



Participants: 41 beginner to advanced L2 speakers of Spanish(22), Hebrew(13), French(5), Hindi(1)

Self Rated L2 Proficiency (LEAP-Q):

	M	*SD*
Speaking	6.15	2.02
Comprehension	7.01	2.09
Reading	6.81	2.05

- No interaction between language switching and previous conflict (no switch by previous-arrow interaction; b = 0.01, SE = 0.01, t = 1.40)

Conclusions

- No evidence for over-additive interactions between language switching and IC demanding tasks, nor for conflict adaptation from IC tasks to language switching.
  - Does not support straightforward role of limited-capacity domain-general IC in language control (at least in language switching tasks).
  - May suggest that IC used for language is fundamentally different from IC tasks here
  - Or may suggest that language switch costs may actually reflect a stay *benefit* (cf. DeBaene et al., 2012; Yeung & Monsell, 2003) that can be disrupted by demand on domain-general IC