



Bilingual Cognitive Control and Age of Acquisition

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Research Questions

Which cognitive control networks are enhanced by bilingualism?
Does earlier Age of Acquisition (AoA) lead to greater cognitive control advantages?

Hypotheses

1. A bilingual advantage will be apparent in both the linguistic (Stroop) and the non-linguistic (ANT) task
2. The bilingual advantage will be modulated by AoA, with greater advantages for earlier AoAs
3. Simultaneous and early sequential bilinguals will differ in their cognitive control abilities

Background

For bilinguals, both languages are active simultaneously¹

Mediating between two languages requires cognitive control

- attention, inhibition, conflict resolution
- bilinguals may have a cognitive control advantage²

Global RT advantages for bilinguals have been observed for the ANT task³

However, inconsistent evidence for bilingual advantage across different tasks (Stroop, ANT, switch tasks, flanker tasks)^{4,5}

Classification of bilinguals may contribute to inconsistency of results

- Simultaneous and early sequential bilinguals often grouped together⁶, but these groups may be fundamentally different

AoA : operationalized as Age of L2 Immersion (Aol)⁷

Methods

Participants

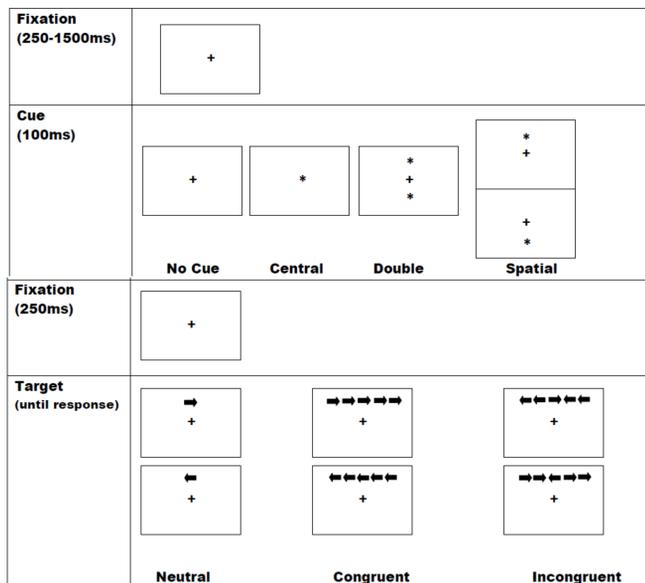
46 young adult (ages 18-26) native speakers of English with varying Aol in French, divided into 3 groups:

- Functional Monolinguals (no immersion; n=17)
- Simultaneous bilinguals (Aol=0; n=12)
- Early Sequential bilinguals (Aol<7; n=17)

Procedure

- Language background questionnaire and written language proficiency tests
- Stroop task and ANT task presented in alternating blocks
- 3 blocks of Stroop, 2 blocks of ANT
- Each block preceded by practice trials and followed by a self-timed break

ANT



$$\text{Alerting} = RT_{(\text{double cue})} - RT_{(\text{no cue})}$$

$$\text{Orienting} = RT_{(\text{spatial cue})} - RT_{(\text{central cue})}$$

$$\text{Executive Control} = RT_{(\text{incongruent trials})} - RT_{(\text{congruent trials})}$$

Stroop Task

Control	Congruent	Incongruent
HOUSE MAISON	RED ROUGE	RED ROUGE

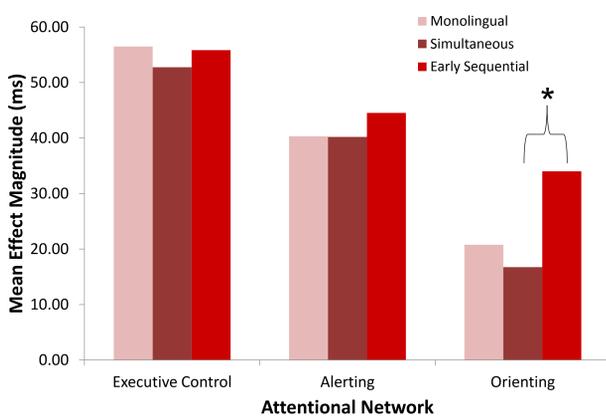
Colour words used

English: RED, GREEN, YELLOW, BLACK, WHITE, SILVER
French: ROUGE, VERT, JAUNE, NOIR, BLANC, ARGENT

	ENGLISH BLOCK	FRENCH BLOCK	BILINGUAL BLOCK
Fixation cross 250ms	+	+	+
Colour word stimulus Until button press	RED	ROUGE	RED
Fixation cross 250ms	+	+	+
Colour word stimulus Until button press	RED	ROUGE	VERT

Results

ANT Mean Effect Magnitudes by AoI



ANT

Significant Orienting advantage for Early Sequential bilinguals ($p=.025$)

No group differences in Executive Control ($p=.88$) and Alerting ($p=.82$) networks

Stroop

No significant differences in single-language blocks. Bilingual block under analysis.

Hypothesis	Result
1. Both linguistic and non-linguistic advantages for bilinguals	✗
2. Greatest advantages for bilinguals with earliest AoA	✗
3. Differences between Simultaneous and Early Sequential Bilinguals	✓

Discussion

Simultaneous bilinguals ≠ early bilinguals

- Acquisition of 2 L1s vs. acquiring an L2
- 1 integrated language system vs. 2 systems
- Similar language skills on surface, but differences in underlying processing

AoI and environment are factors in bilingual cognitive control
• Improved abilities for Early bilinguals: why Orienting?

Lack of effects in Stroop task may reflect insufficient task difficulty

- Young adult bilinguals at peak of executive control
- Effects emerge in more challenging environment

Functional monolinguals vs. true monolinguals

- The bilingual environment at the University of Ottawa

References

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Acknowledgements

This research was funded by a Social Sciences and Humanities Research Council of Canada grant to the second author. Thank you to Sameer Ratti, Yu Ying Li, and Natalie Ho for all their help with testing, Christie Brien, Michele Burkholder, and all of the wonderful members of the Brain and Language Laboratory at the University of Ottawa for invaluable discussion, and to all of our participants for their time and enthusiasm!

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