Context-dependent bilingual advantages: Roles of language and working memory

Grace Cannon* & Hanako Yoshida
*gcannon@uh.edu

UNIVERSITY of HOUSTON

INTRODUCTION

Motivation

- Previous research concerning bilingual and monolingual differences in cognitive control ability is inconsistent.
- *Past results have shown either BL interference effects or global executive advantages—including attention, inhibition, shifting.*
- Certain studies indicate that differences in cognitive control occur solely due to working memory ability, not bilingualism.
- *Bilingual cognitive control develops via language-specific processes, strictly via auditory input during early childhood.*

Objectives

1. Examine cognitive control in monolingual and bilingual children receiving varied on-line language input within a task.
2. Identify relationships of verbal and nonverbal working memory with cognitive control as this language input varies.

Hypotheses

1. Task-specific language input will interact with bilingualism:
   - Added semantic input will reduce BL advantage.
   - Added auditory (speech) input will increase BL advantage.
2. Verbal and non-verbal working memory will predict cognitive control only for tasks that involve the same domain.

METHOD

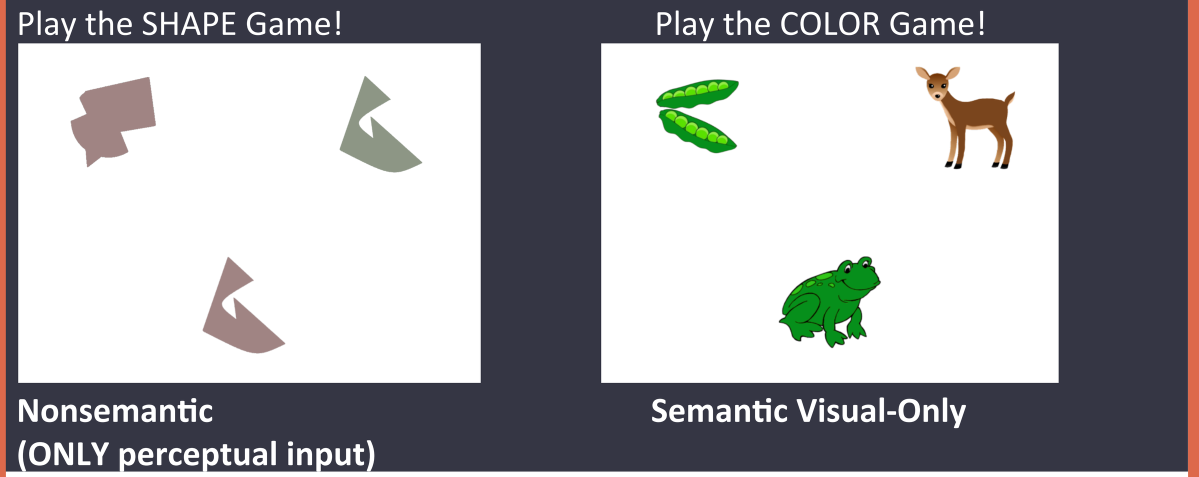
Participants

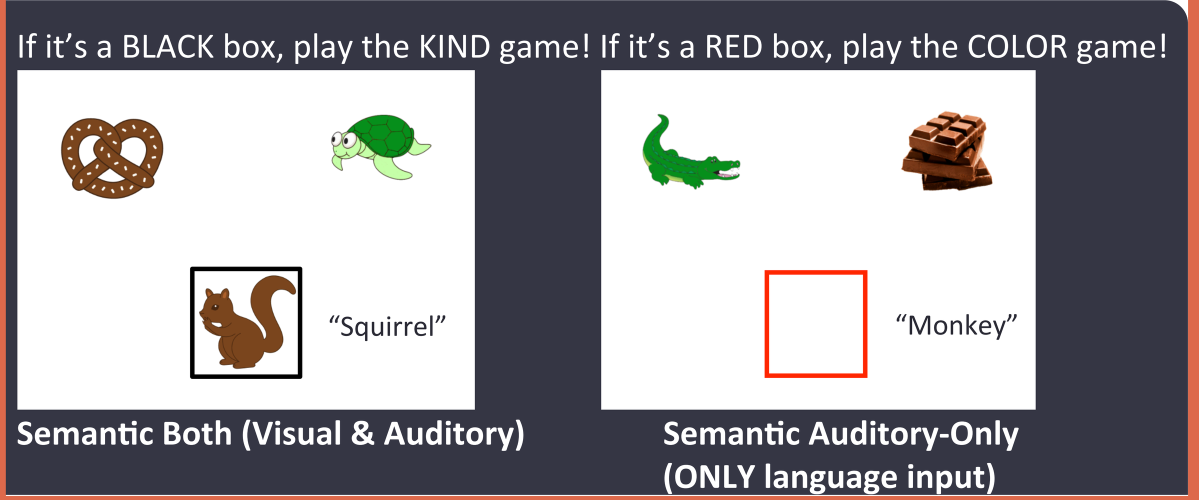
N=26 children (M=66.25, SD=6.74 months)

- 12 BL (5 Hispanic, 6 female); 14 ML (5 Hispanic, 9 female)

Design

- **Language-input**: Four conditions of Dimensional Change Card-Sort for cognitive control (DCCS; Frye, Zelazo, & Palfai, 1995):
  - **Language-input** manipulated: Semantic, Visual, Auditory
  - Adding Semantic and Auditory input provides language
- **Complex word recall:** testing verbal working memory with yes/no "alive" judgment (modified from Alloway, 2007)
- **Complex spatial recall:** testing spatial working memory with yes/no "star" judgment (Cirino, 2011)





LANGUAGE

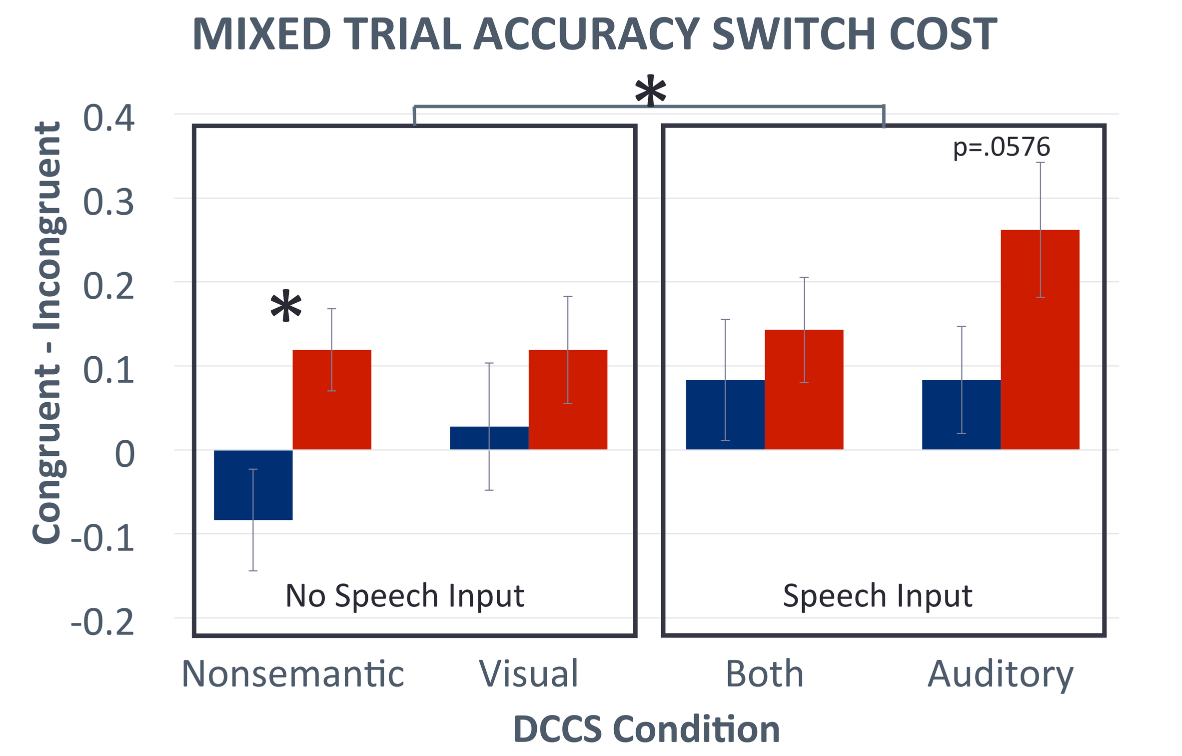
Accuracy

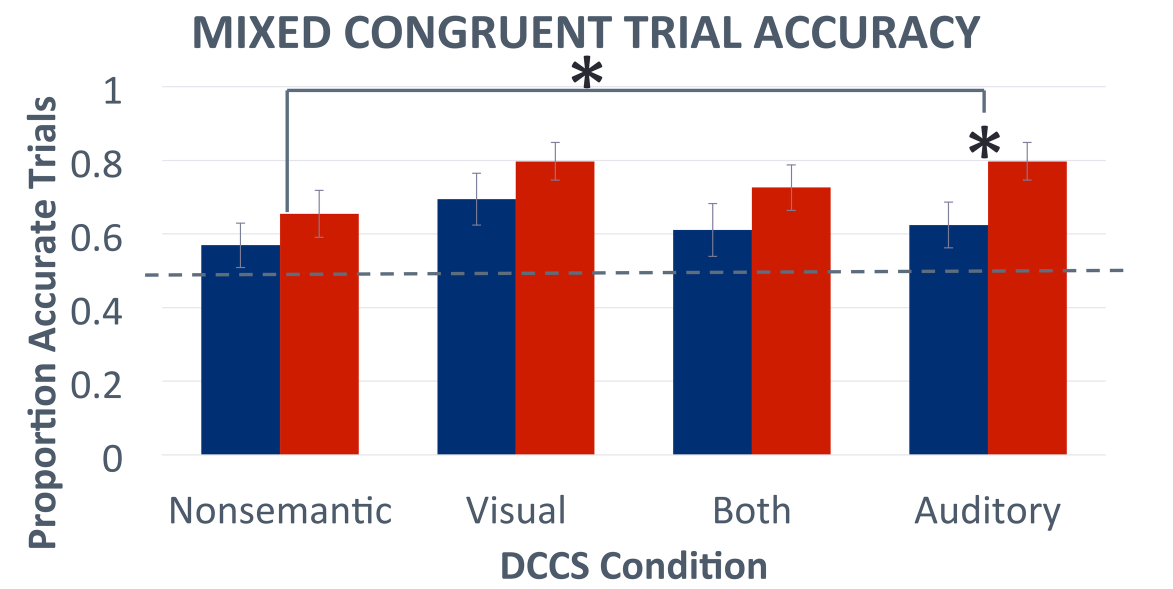
- ***Bilinguals** showed a smaller switch cost in the mixed trials.*
  - Due primarily to *lower BL accuracy on congruent trials.*
  - *Largest BL effects on Nonsemantic and Semantic-Auditory.*
  - Larger switch costs overall for two Auditory (speech) tasks.
- **Language-input** predicted accuracy on congruent trials: greater accuracy on Semantic-Auditory than Nonsemantic.
  - *Largest ML congruency advantage on Semantic-Auditory.*
- **Vocabulary** predicted higher accuracy for incongruent trials.

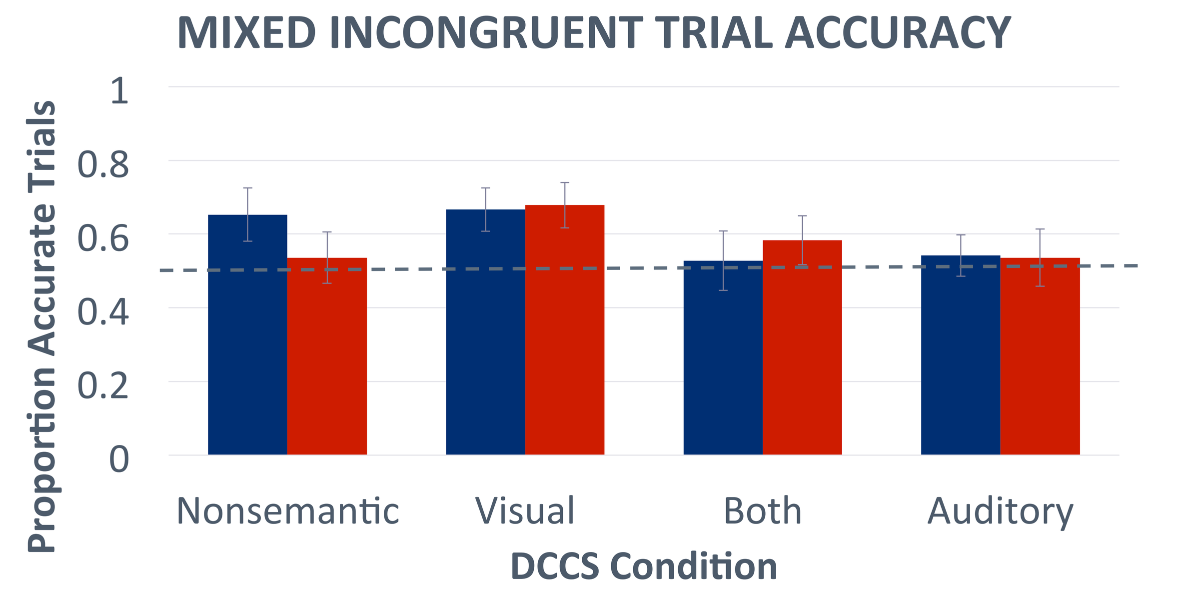
Reaction Time

- **Vocabulary** predicted larger block switch cost.

Legend:
- Bilingual
- Monolingual







WORKING MEMORY

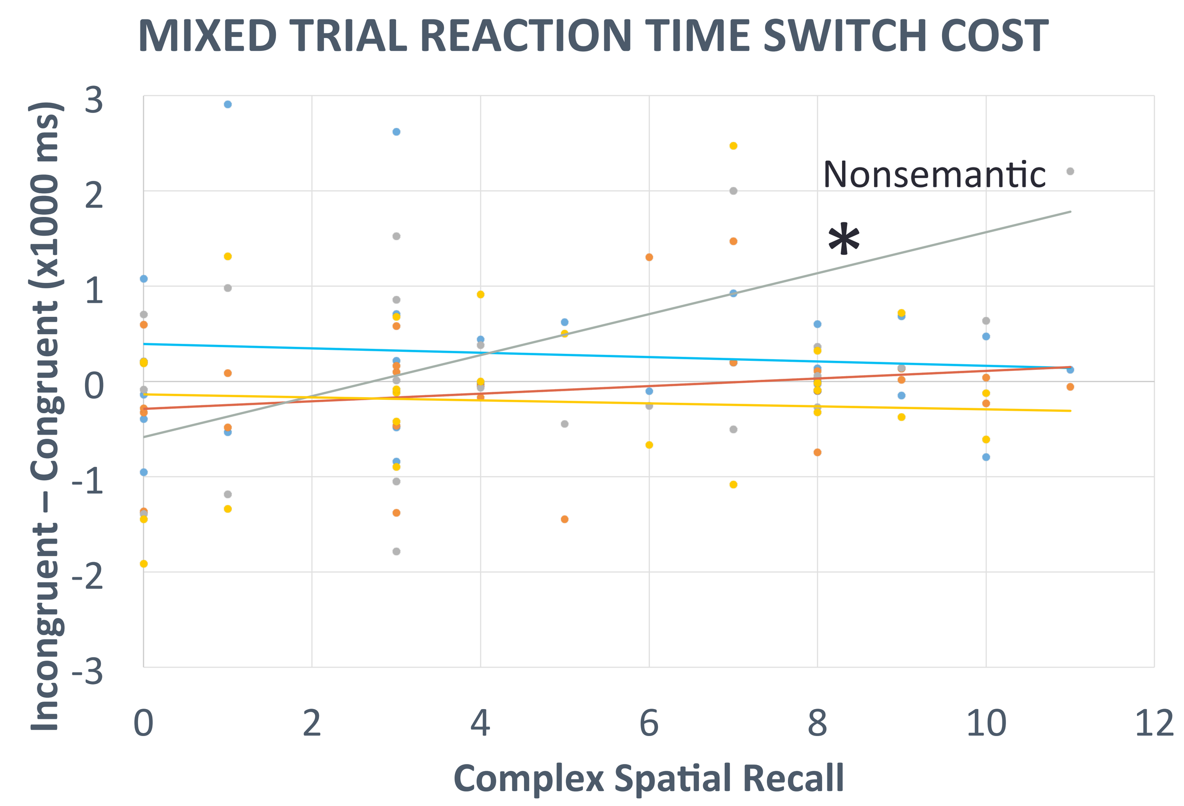
Accuracy

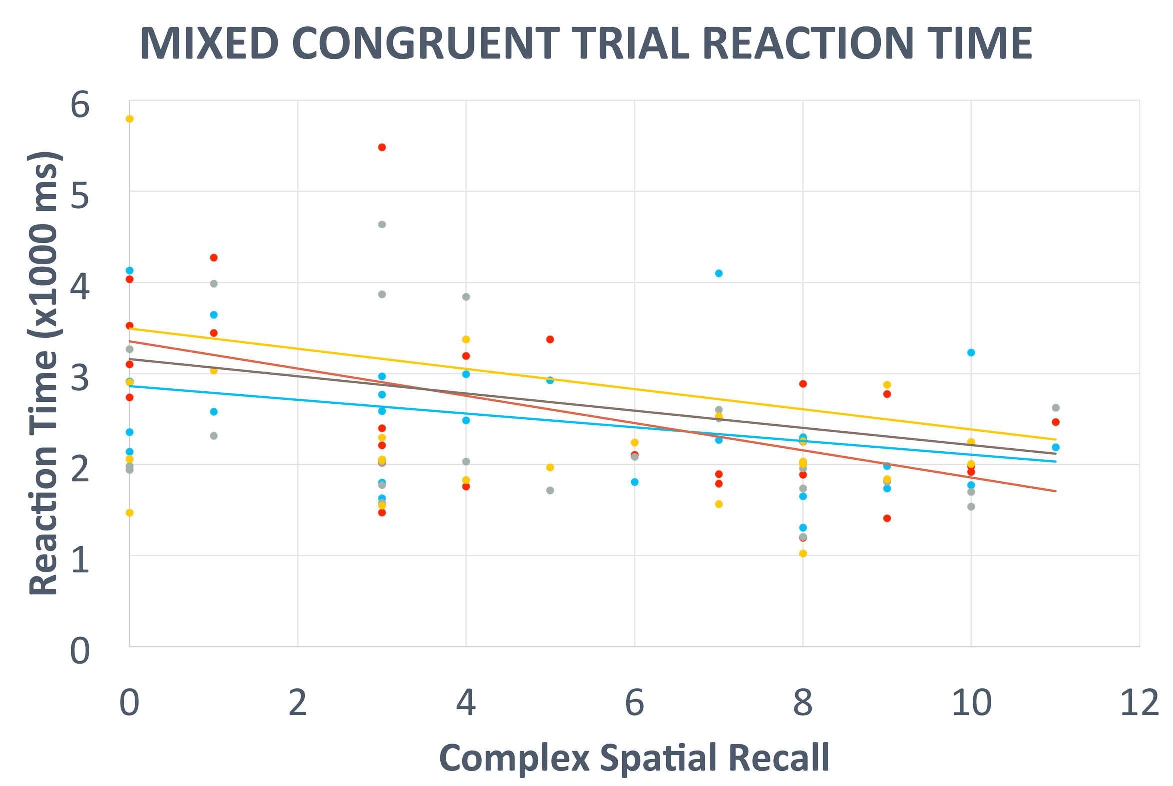
- **Verbal WM** scores predicted higher accuracy for congruent trials, regardless of semantic or speech input.

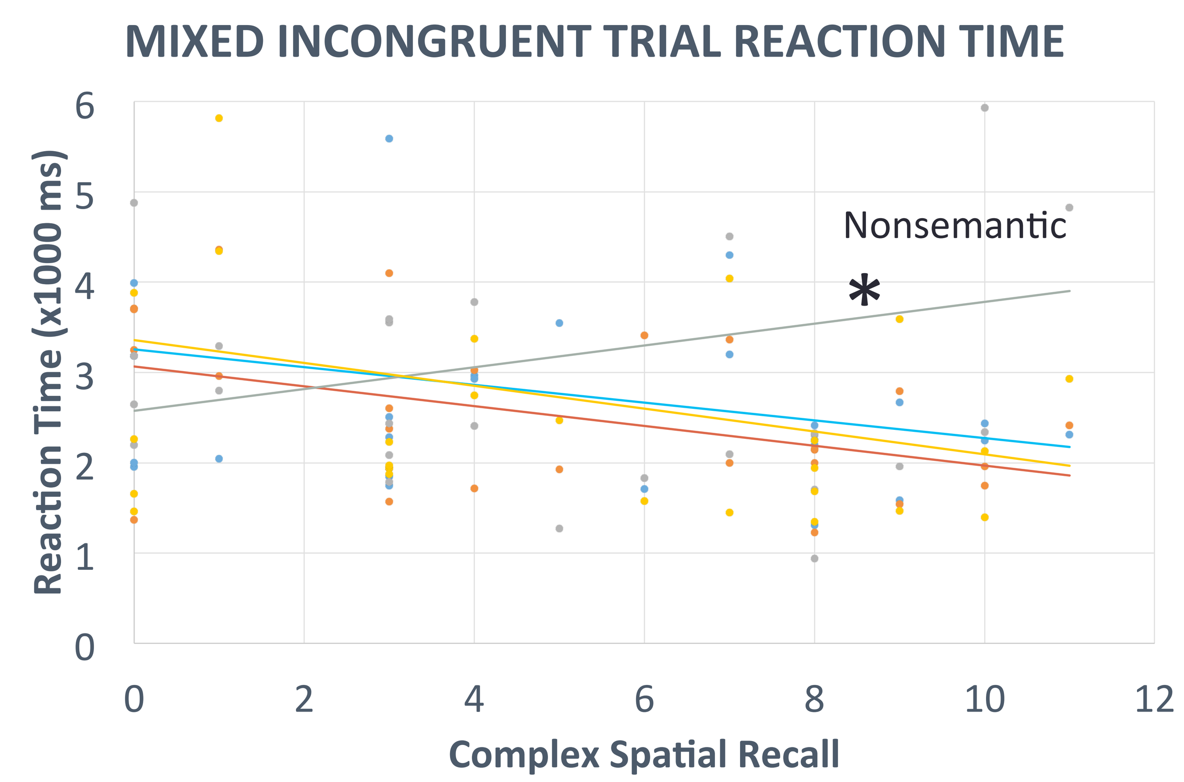
Legend:
- Nonsemantic
- Visual
- Both
- Auditory

Reaction time

- **Spatial WM** scores interacted with **language-input** for RT on incongruent trials, but not on congruent trials.
- **Spatial WM** scores interacted with **language-input** for RT trial switch cost.
- Better spatial WM predicted *slower incongruent RT* and *larger RT costs* for the Nonsemantic condition, but not for any of the three Semantic (language-based) conditions.







ANALYSES

- Preliminary t-tests showed no differences between language groups on any background measures, or working memory.
- *Separate ANCOVAs for accuracy and reaction time with the four language-input conditions as outcomes were conducted:*
  - Preswitch; postswitch; block switch cost (accuracy,WM *ns*)
  - *Mixed block: Congruent trials (same sorting rule); incongruent trials (new sorting rule); trial switch cost*
  - Vocabulary, age, Verbal and Spatial WM as covariates.
- *Separate regressions with Verbal WM and Spatial WM as predictors were conducted for the same outcome variables.*

Descriptive Statistics: M(SD)

	Total	Monolingual	Bilingual	p-value
Age (months)	66.3 (6.9)	66.4 (6.7)	66.1 (7.4)	.9184
Maternal Education (years)	17.1 (2.5)	16.9 (2.4)	17.3 (2.7)	.6396
Paternal Education (years)	17.3 (2.8)	16.5 (2.5)	18.3 (3.0)	.1171
PPVT Raw Score	107.6 (23.7)	109.9 (27.0)	104.9 (20.2)	.6019
PPVT Standard Score	113.5 (16.60	115.1 (18.3)	111.7 (14.9)	.6046
PPVT Age Equivalent	6.7 (1.5)	6.9 (1.8)	6.5 (1.3)	.5116
Verbal WM	10.6 (4.0)	10.5 (4.7)	10.7 (3.3)	.9188
Spatial WM	5.0 (3.6)	5.0 (3.9)	5.1 (3.3)	.9540
Forward Digit Span	25.8 (4.2)	25.6 (5.2)	25.9 (2.7)	.8662
Backward Digit Span	7.1 (3.6)	6.5(4.3)	7.9 (5.7)	.3338

DISCUSSION

Hypothesis 1

Bilingual advantages appear only when comparing an interference (incongruent) to a non-interference (congruent) context.

- Monolingual congruent advantages indicate a buffering effect of bilingual cognitive control, not a general advantage.

Trends across language-input conditions indicate two possible mechanisms for BL interference effects dependent on input.

- *Bilinguals may have a typical advantage on Nonsemantic tasks, but a buffering effect specific to Semantic and Auditory tasks.*

Hypothesis 2

While Verbal WM corresponds to faster congruent RTs, Spatial WM predicts slower incongruent RTs only for a Nonsemantic task.

- Verbal and nonverbal WM affect related cognitive control tasks differently, specifically raising questions for future research about the mechanisms of visual-spatial processing for development of nonverbal WM.

Controlling for working memory, bilingual advantages remained present, with language groups matched on those measures.

- *This also provides support for the claim that WM influences cognitive control uniquely from bilingualism.*

Conclusion

Bilingual cognitive advantages may appear more typically in interference contexts, although the nature of advantages may vary due to mechanisms specific to semantic or speech processing.

ACKNOWLEDGEMENTS

Funding is by R01 HD058620; Foundation of Child Development (Young Scholars Program); and UH Grants to Enhance and Advance Research (GEAR). Authors are solely responsible for the content and do not necessarily represent the official views of NIH.