THE GRADUATE CENTER
CITY UNIVERSITY OF NEW YORK

DO BILINGUAL CHILDREN PERFORM MORE EFFICIENTLY IN EXPERIMENTAL TASKS THAN THEIR MONOLINGUAL PEERS?

KLARA MARTON

ACKNOWLEDGEMENT

- Funding:
- NIH – NIDCD 1R15DC009040-01;
- European Union and the European Social Fund, TÁMOP
- Several internal PSC-CUNY awards

- Special thanks to Luca Campanelli for
- the data analyses!

- Collaborators at the GC: Mira Goral & Loraine K. Obler

- Doctoral students: Luca Campanelli, Jessica Scheuer, Veronika Stepanoff, Jungmee Yoon, J.P. Benabe Vidal, Deepti Wadhera, Deniz Erol, Timea Egri

- Master's and undergraduate students: Reka Kovacs, David Puerta

IS THERE A BILINGUAL COGNITIVE ADVANTAGE IN CHILDREN?

- There is evidence for and against it.

- Supporting findings:
- There is an advantage in specific cognitive functions: e.g., distractor and proactive interference (Bialystok et al., 2008);

- There is a general advantage in speed of processing (e.g., Kousaie and Phillips, 2012);

FACTORS BEHIND THE INCONSISTENCIES

- **Participant variables**:
  - Language proficiency (Iluz-Cohen & Armon-Lotem, 2013)
  - Similarities between the languages spoken (Bialystok, Majumder, & Martin, 2003)
  - Language of education (Bialystok et al., 2010)
  - Age of acquisition (Carlson & Meltzoff, 2008)
  - Speed of processing (Martin-Rhee & Bialystok, 2008)
  - ….
  - **SES** (Morton & Harper, 2007)
  - **Cultural background** - differences in early socialization (Sabbagh et al., 2006)

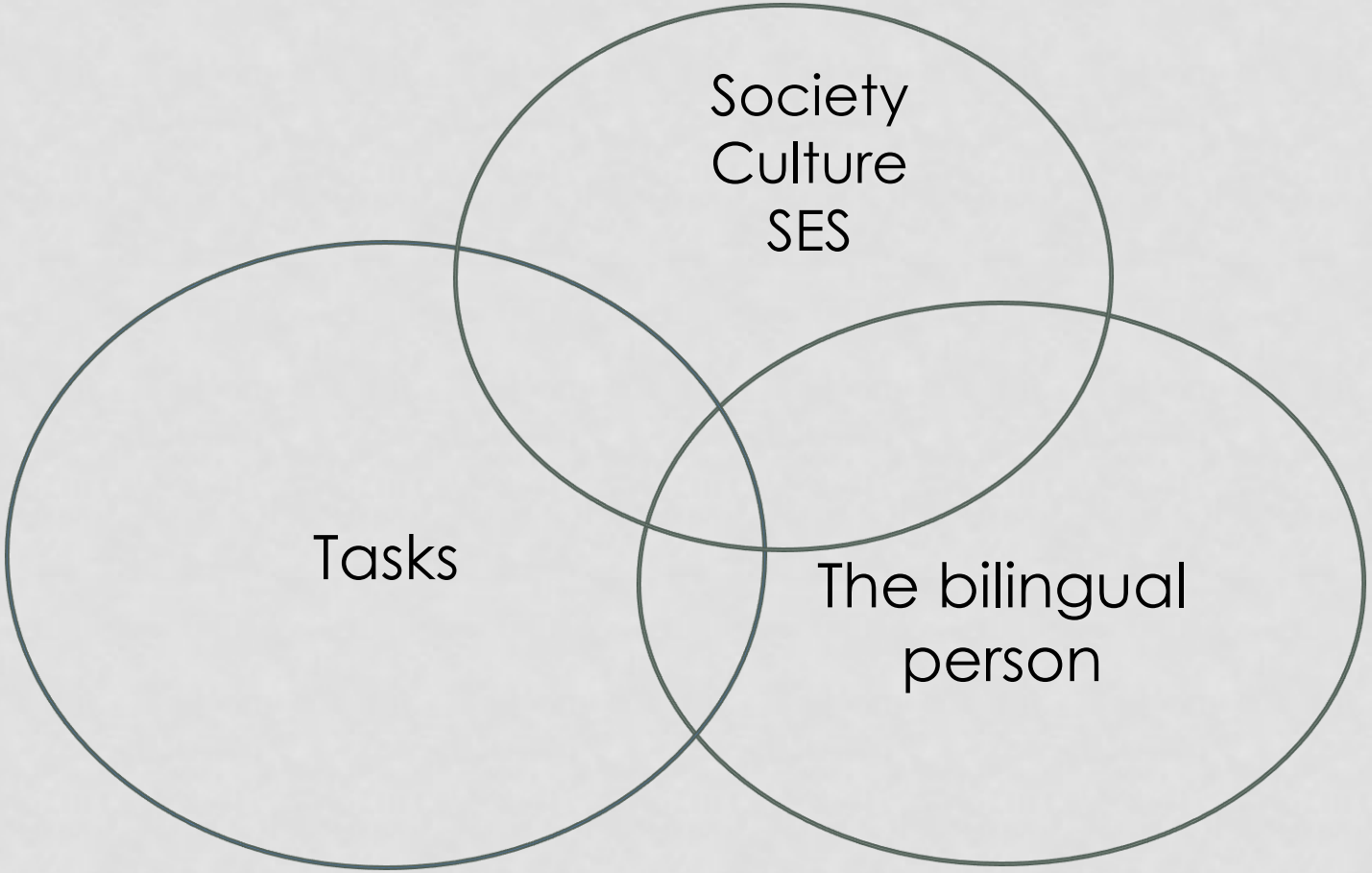
- **Task types**
  - standardized tests (e.g., Wechsler IQ test)
  - tasks providing global measures (e.g., Wisconsin card sorting, Stroop)
  - tasks with experimental manipulations

- **Functions**

  - visual perspective taking: global-local (Bialystok, 2010)
  - working memory (Morales, Calvo, & Bialystok, 2013)
  - short-term memory (Bonifacci et al., 2011)
  - withholding a response (Bonifacci et al., 2011; Martin-Rhee & Bialystok, 2008)
  - …….

	Language Proficiency	Simila-rities btw languages	Age of acquisition	SES	Culture	Speed of processing
Rule switching	✔	✖				✔
Visual perspective taking	✔					✔
WM				✔		✔
STM	✖					
Response inhibition	✖		✖		✔✖	✖
Distractor. interference			✖	✔		✔✖
PI				✔		✔
Anticipation	✔					✔

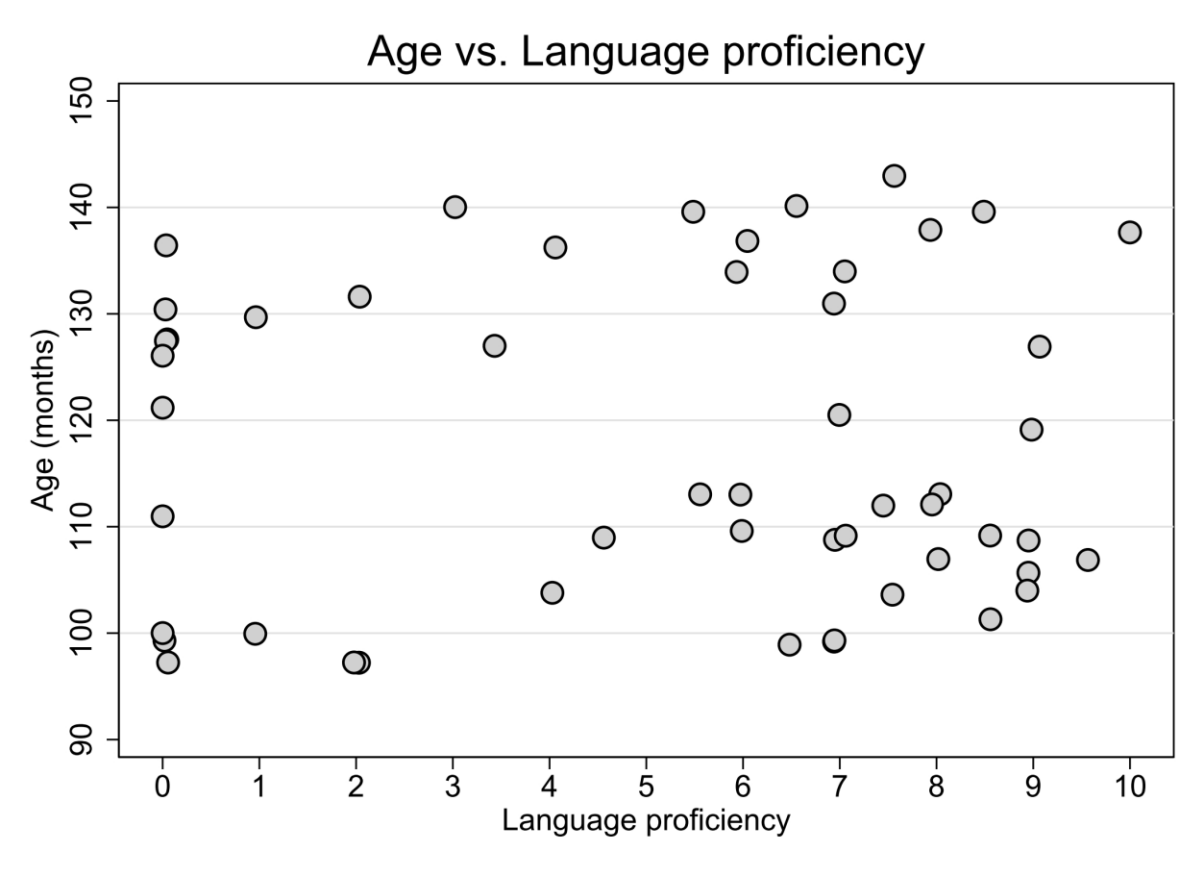
FACTORS ASSOCIATED WITH BILINGUAL EXECUTIVE PROCESSING



STUDY 1: CHILDREN WITH ENGLISH AS THEIR PRIMARY LANGUAGE

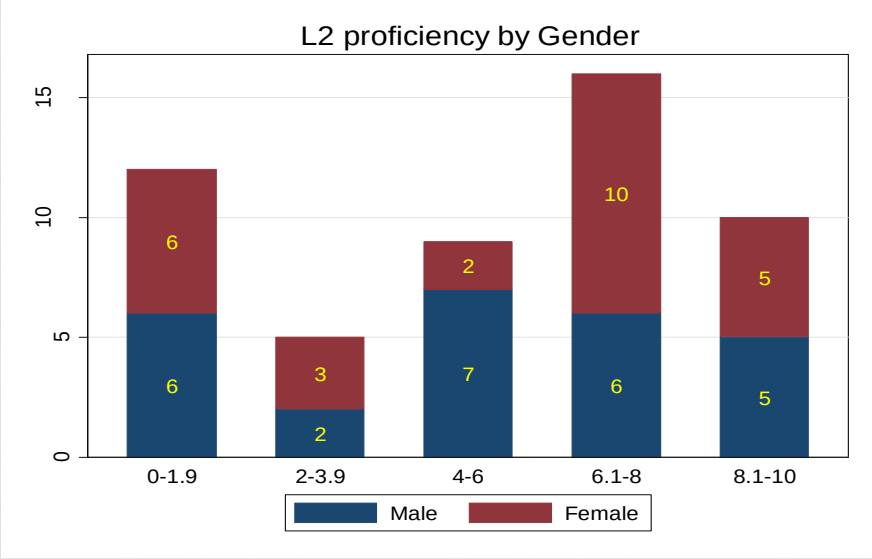
- Goals:
- To study the relationship between language proficiency and executive processing in school-age children;
- To examine whether children with different proficiency levels show strengths and weaknesses in different EFs;
- To explore the relationship between language proficiency and overall speed of processing;
- To examine whether the frequency of language use shows a relationship with EFs.

PARTICIPANTS
N=52

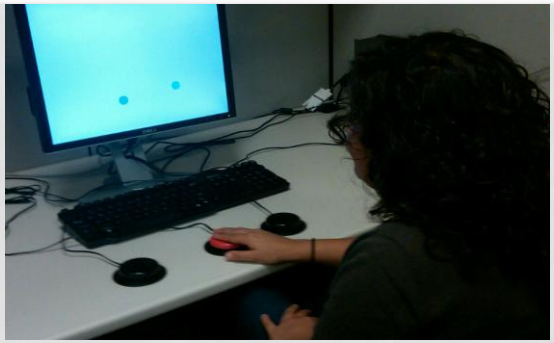


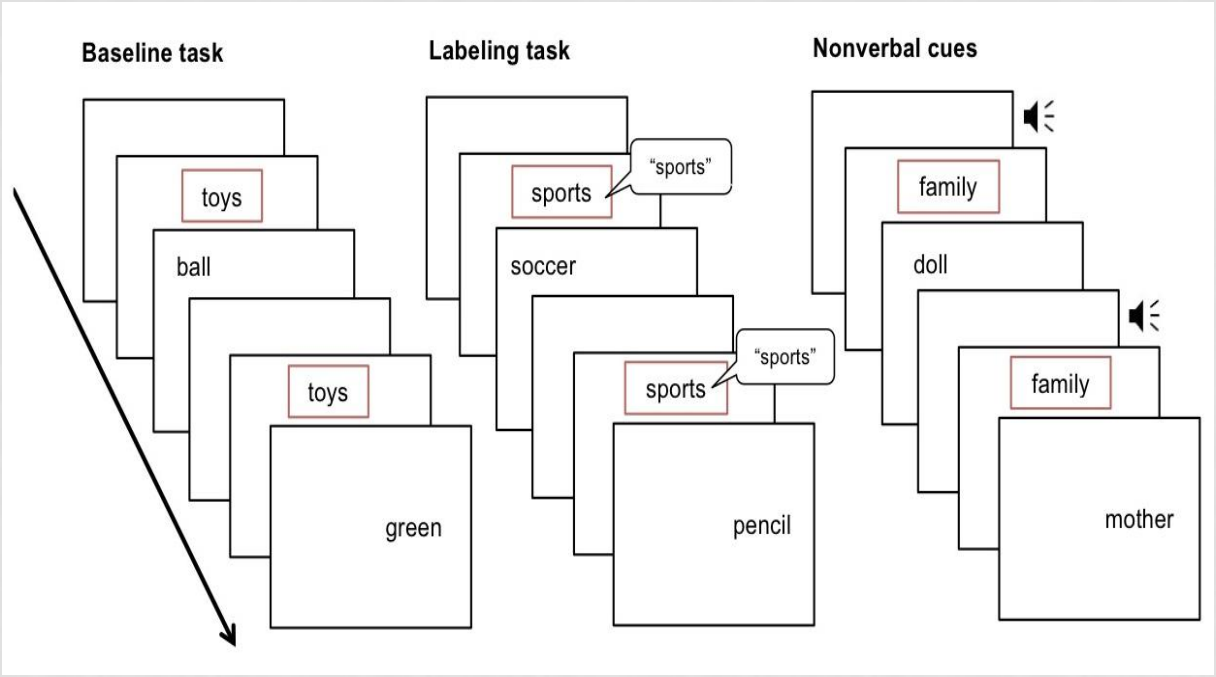
Proficiency as a continuous variable

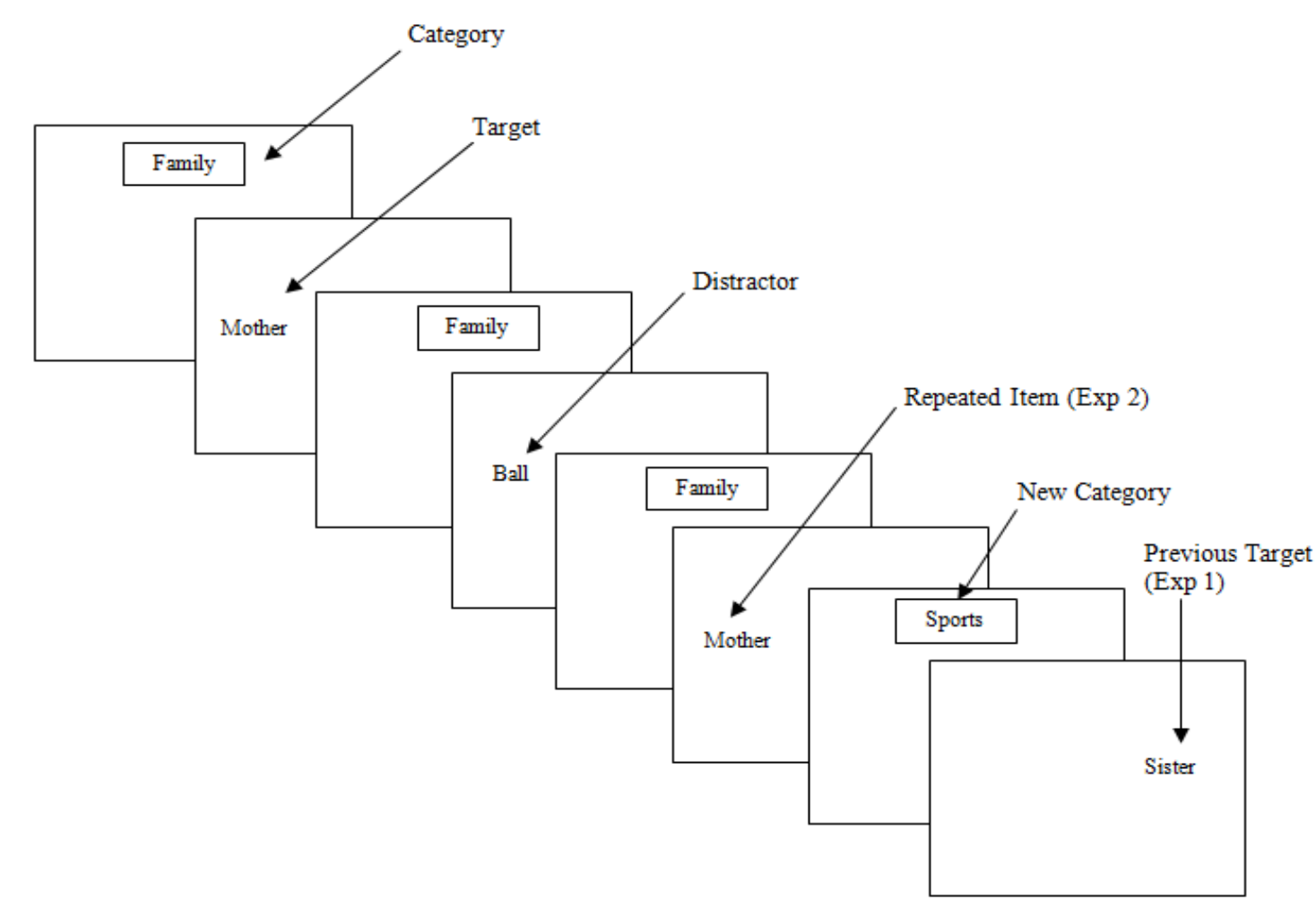
	Mean	SD
Age (months)	117.7	14.9
IQ (TONI)	114.8	17.4
Language (CELF)	107.4	10.9



TASKS

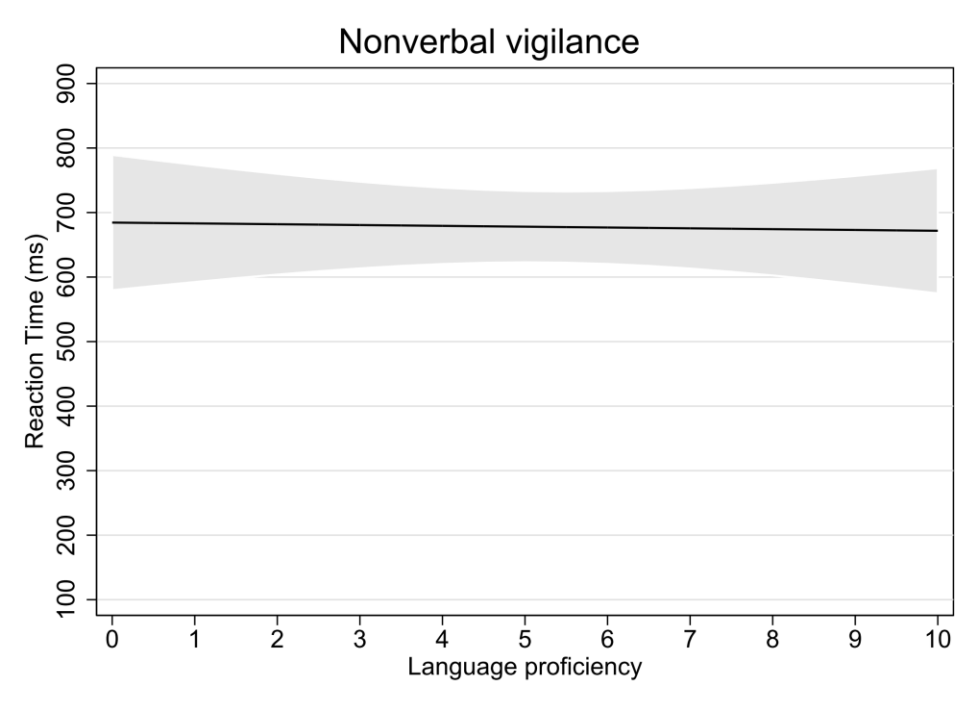



Baseline task
Labeling task
Nonverbal cues
toys
ball
toys
green
sports
"sports"
soccer
sports
"sports"
pencil
family
doll
family
mother



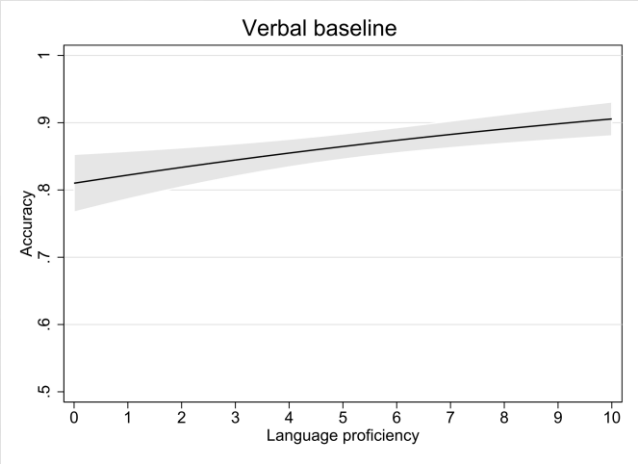
Data analysis: Mixed effects modeling

BASELINE NONVERBAL SPEED OF PROCESSING



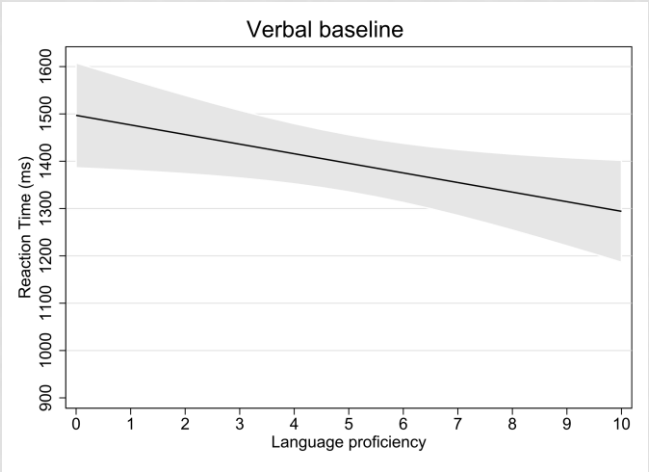
RT	Coefficient	p
Language proficiency	0.004	0.73

VERBAL BASELINE

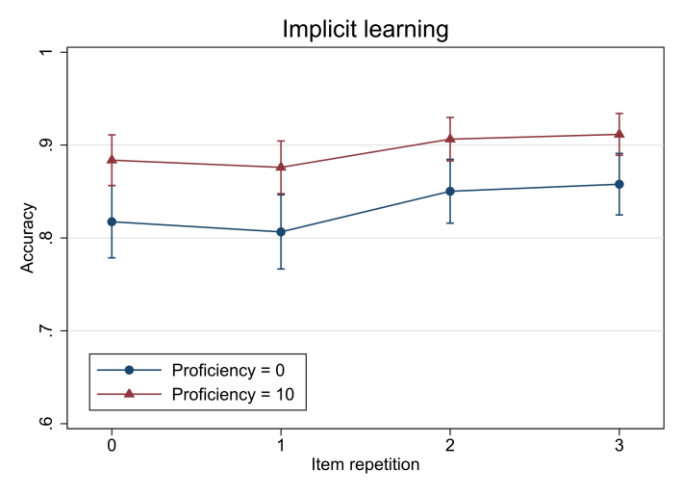


Accuracy	Coefficient	p <
Language proficiency	0.08	0.001

RT	Coefficient	p <
Language proficiency	0.083	0.001

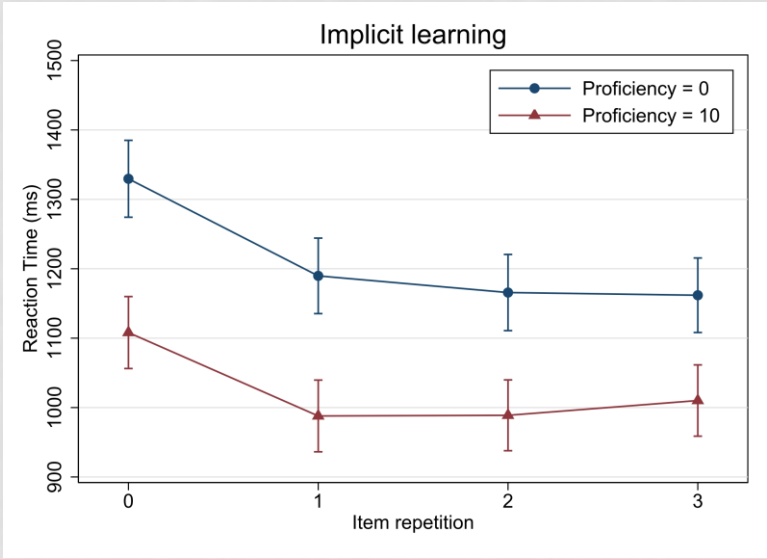


IMPLICIT LEARNING

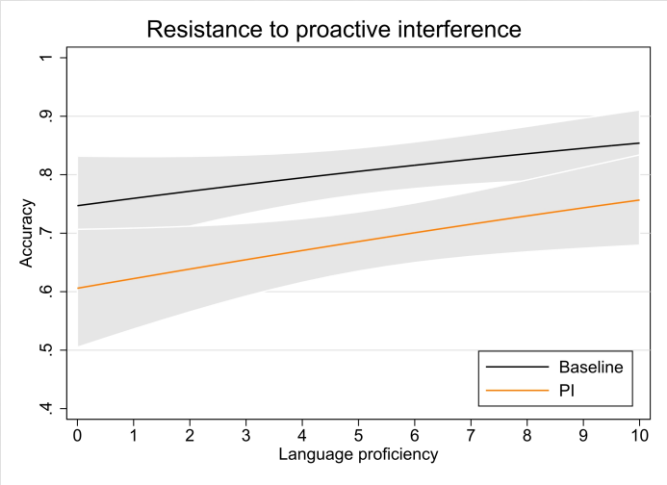


Accuracy	Coefficient	p
Language proficiency	0.06	0.16
condition	0.6	0.17

RT	Coefficient	p <
Language proficiency	-18.71	0.01
Condition	0.09	0.01

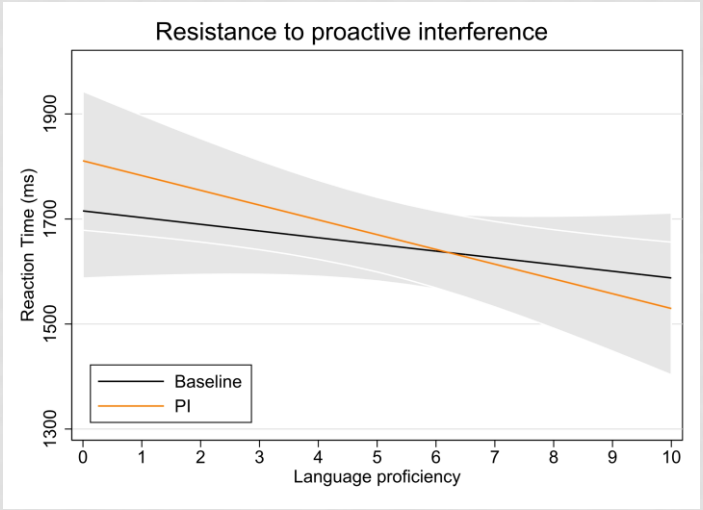


PROACTIVE INTERFERENCE

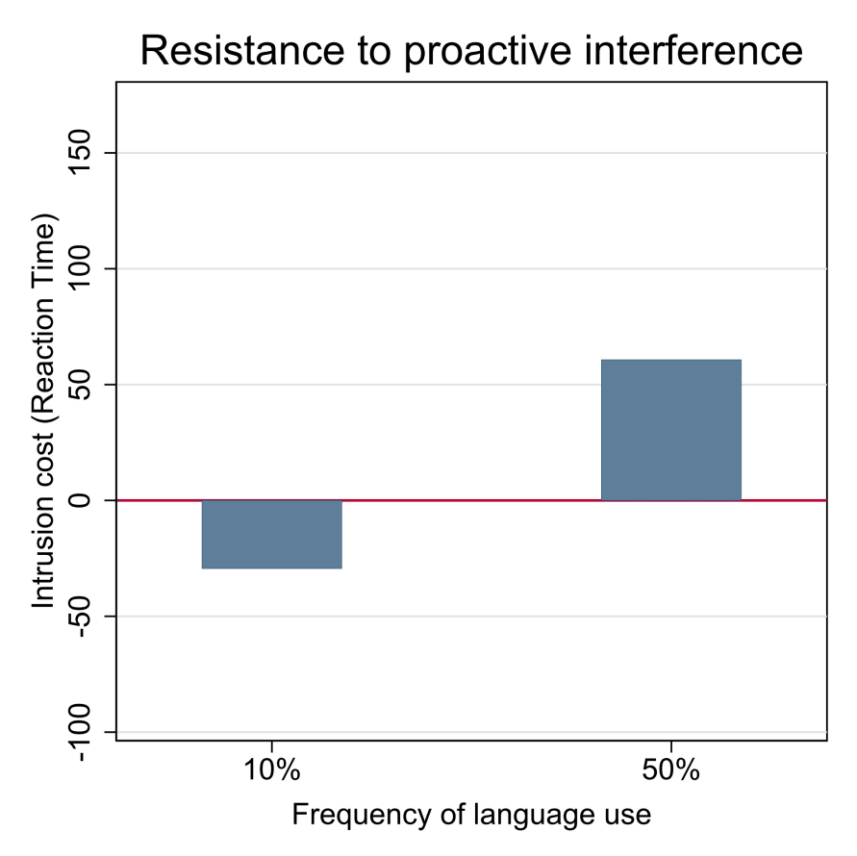


Accuracy	Coefficient	p <
Language proficiency	0.08	0.05
Condition	-0.72	0.001

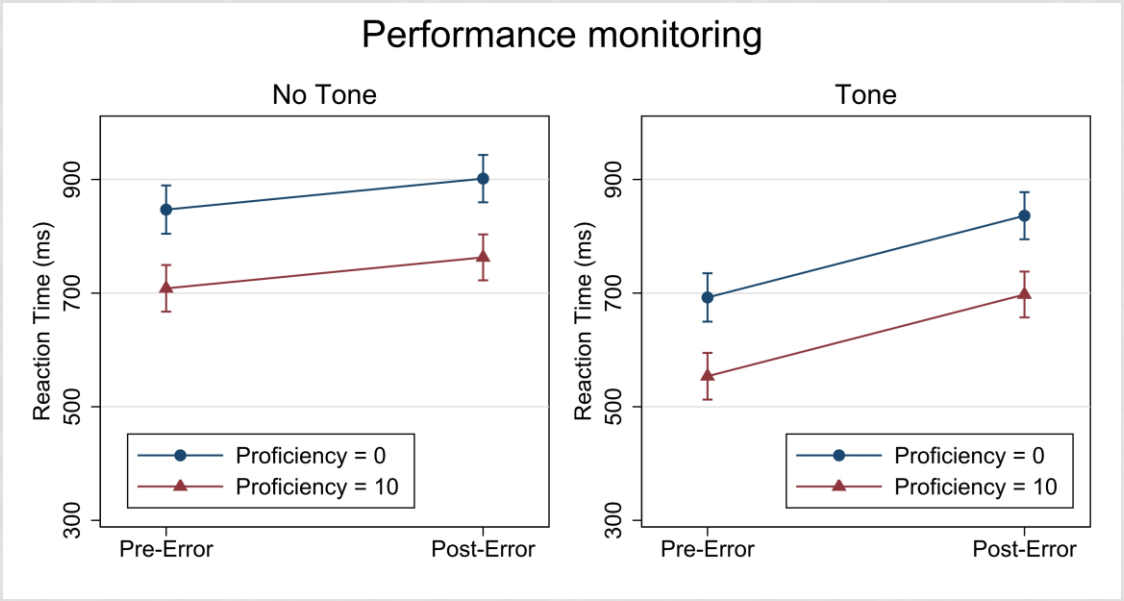
RT	Coefficient	p <
Language proficiency	-13.24	0.2
Condition	86.37	0.05
Proficiency x condition	-14.64	0.05



LANGUAGE USE AND INTERFERENCE

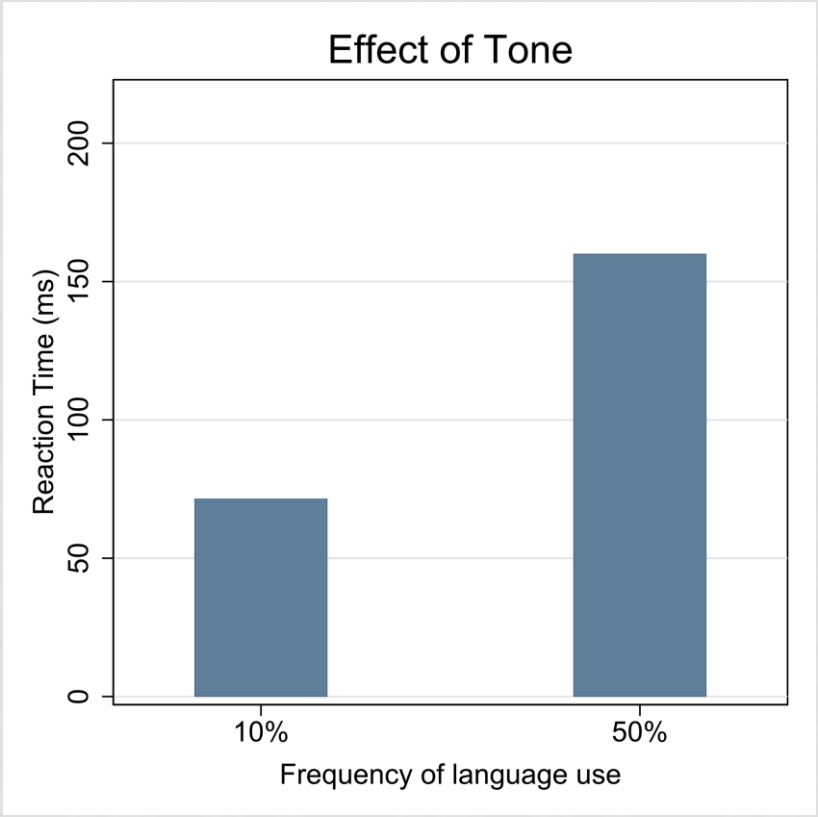


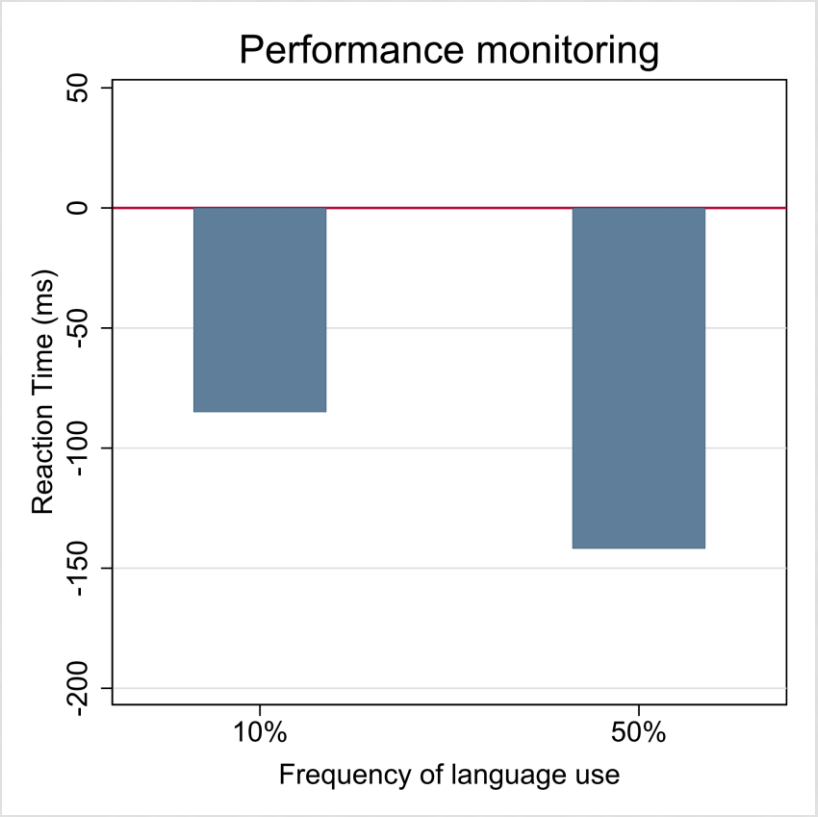
PERFORMANCE MONITORING



Post error slowing	Coefficient	p <
Language proficiency	-13.86	0.05
Condition	-154.66	0.001
Error monitoring	54.53	0.05
Error monit. x condition	89.33	0.01

LANGUAGE USE AND PERFORMANCE MONITORING





SUMMARY 1

- There is an association between language proficiency and executive processing but this relationship is not a unitary one;
  - Bilingual advantage in resistance to proactive interference;
  - Similar performance patterns across children with different proficiency levels in implicit learning and performance monitoring.

- Overall speed of processing and language proficiency show a positive correlation in various verbal EF tasks.

- In addition to language proficiency, the frequency of language use also shows an interaction with EFs.

  - Those highly proficient bilingual children, who use both languages on a regular basis (50%-50%), show smaller intrusion cost and larger post-error slowing than highly proficient children with less frequent language use of the weaker language.

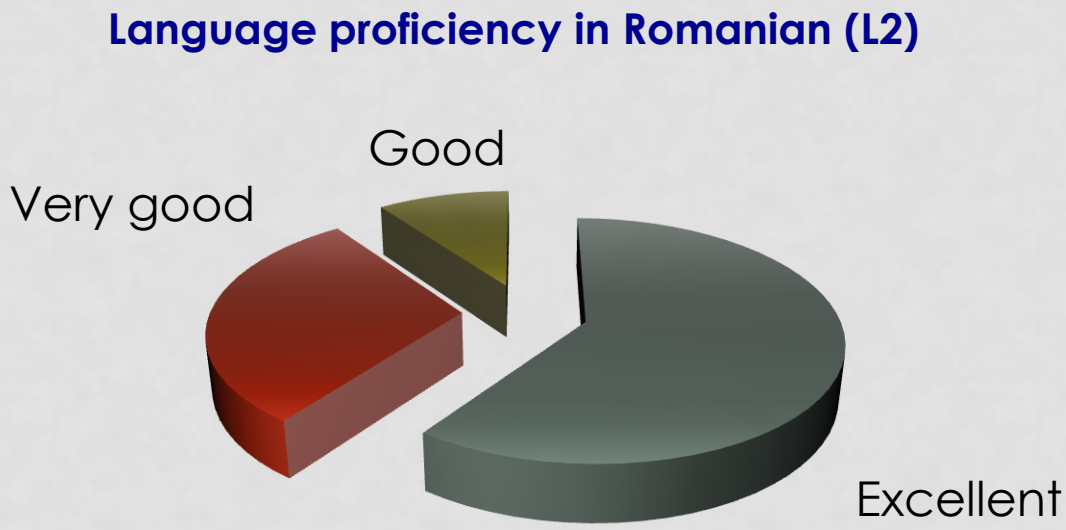
STUDY 2: HUNGARIAN-ROMANIAN CHILDREN

- Goals: To test executive processing in highly proficient bilingual children from similar cultural background, SES, and language of education.

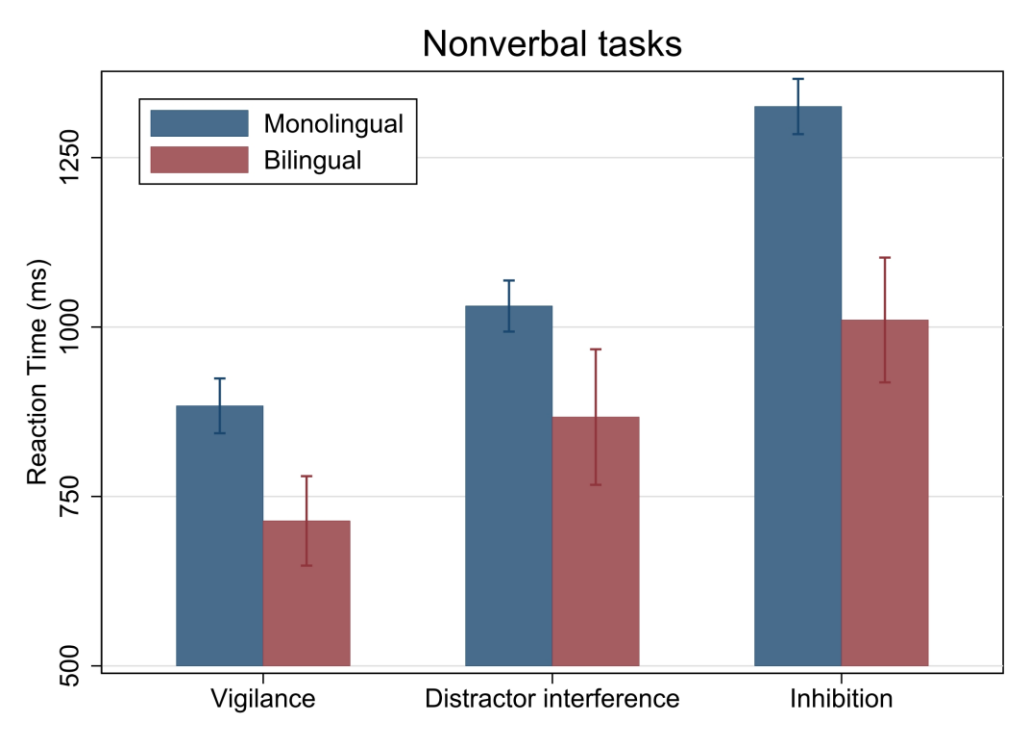
- To examine the relationship between executive processing and speed of processing in highly proficient bilingual children.

PARTICIPANTS

- 18 monolingual children
- 13 Hu-Ro bilingual children
- Ages: 8-10 yrs
- L1: Hu (dominant language)

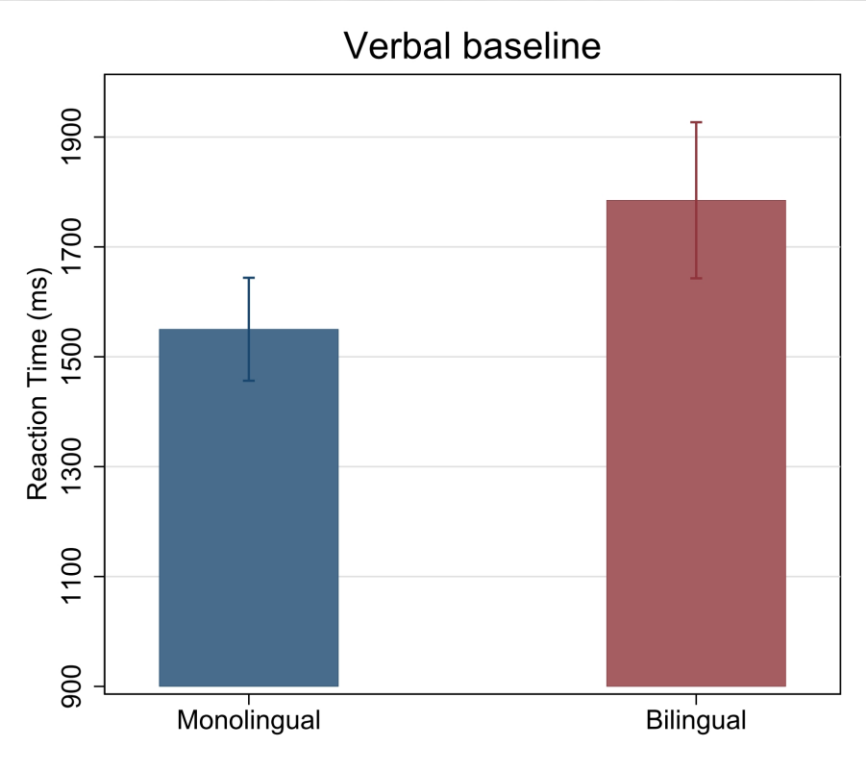


NONVERBAL BASELINE



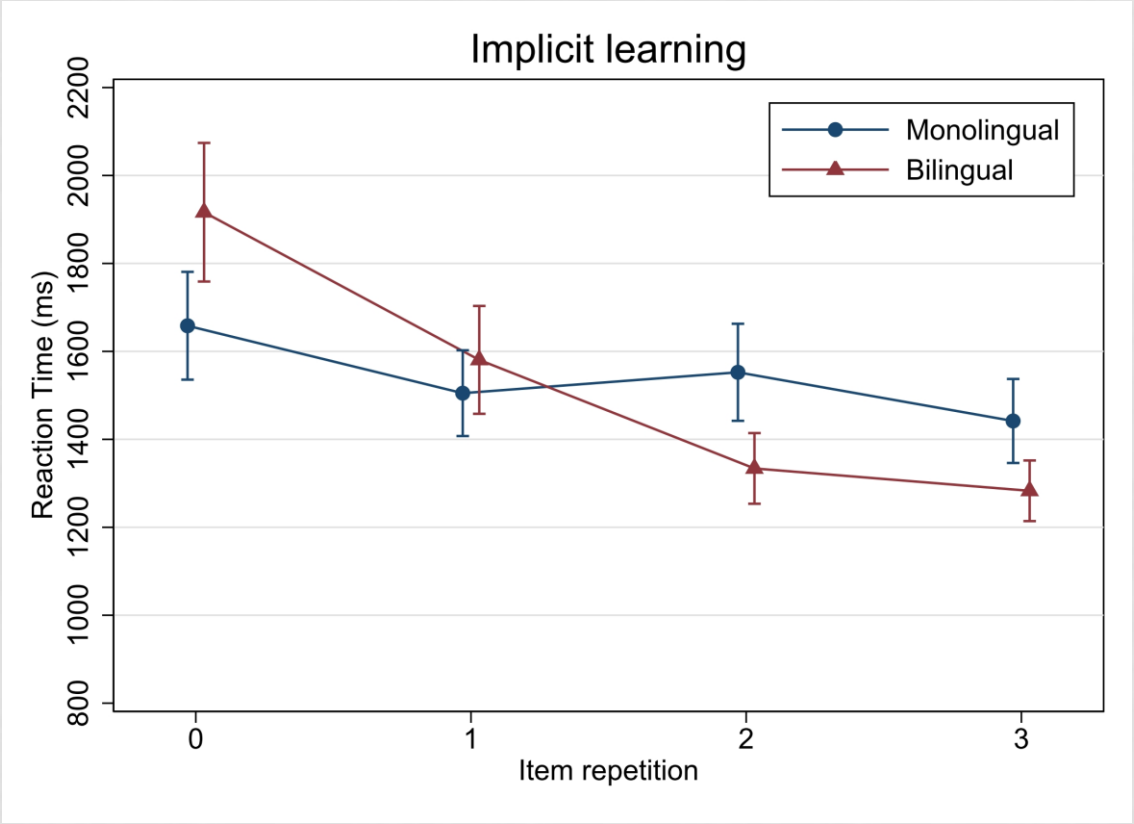
RT	Coefficient	p <
Group	-168.61	0.05
Task	148.93	0.001
Group x task 1C	-153.88	0.001

VERBAL BASELINE



RT	Coefficient	p
Group	214.89	0.16

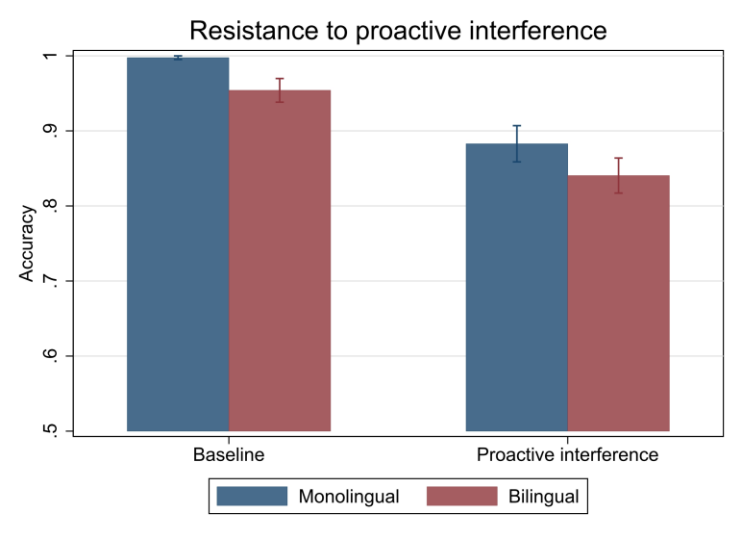
IMPLICIT LEARNING



RT	Coefficient	p <
RT	267.25	0.06
repetition 1	-133.05	0.05
repetition 3	-186.58	0.001
group x repetition 1	-201.09	0.05
group x repetition 2	-491.97	0.001
group x repetition 3	-431.11	0.001

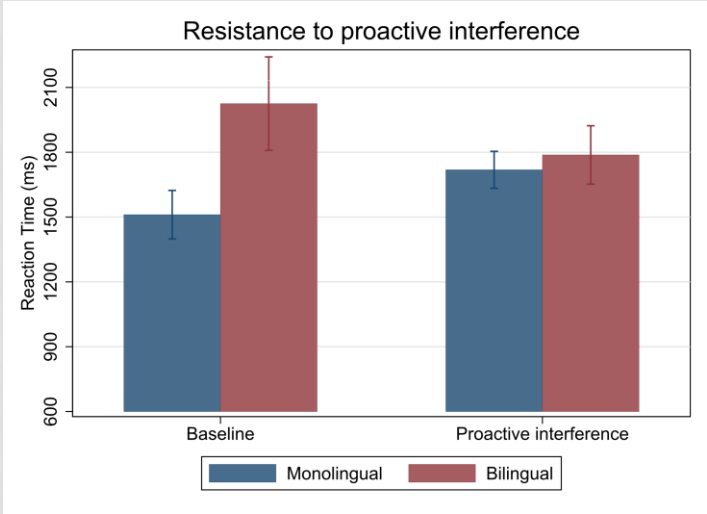
Correlation between language use and learning curve: more frequent language use – steeper learning curve (r = 0.56).

PROACTIVE INTERFERENCE



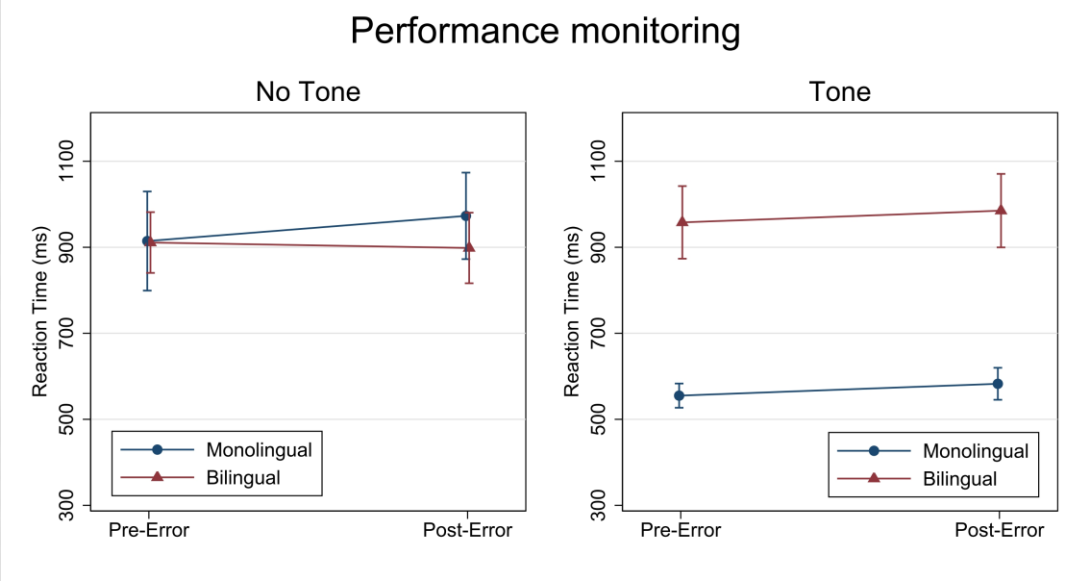
Accuracy	Coefficient	p <
Group	-4.05	0.001
Condition	-3.06	0.01
Group x condition	2.65	0.05

RT	Coefficient	p <
Group	505.93	0.01
Condition	201.81	0.001
Proficiency x condition	-407.62	0.001



Correlation: steeper learning curve – smaller intrusion cost (r = 0.61)

PERFORMANCE MONITORING



Post error slowing	Coefficient	p <
Group	--38.45	0.8
Condition	-325.5	0.05
Error monitoring	99.1	0.49
Tone x group	354.36	0.05

Negative correlation between post error slowing & RT in implicit learning (r = -0.64)

SUMMARY 2

- Several significant interactions between task condition and group:
  - RT in implicit learning: bilingual children showed steeper learning curve;
  - Monolingual children showed larger intrusion cost in the PI condition;
  - In performance monitoring the monolingual children benefitted more from the external cue than the bilingual children.

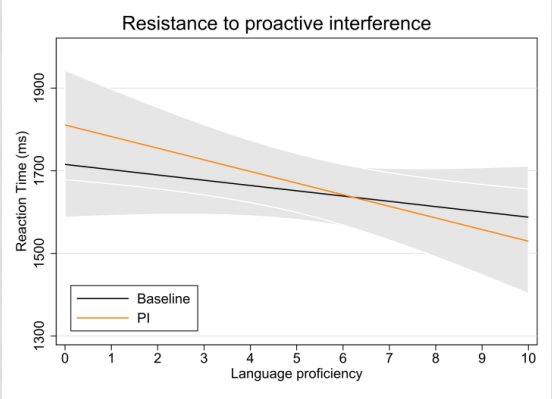
- Unlike the American children, the Hu-Ro bilingual children did not differ from their monolingual peers in verbal baseline measures but showed an advantage in nonverbal baseline;

- Verbal baseline results in bilingual children across tasks may reflect the influence of the language context – the official language is Romanian.

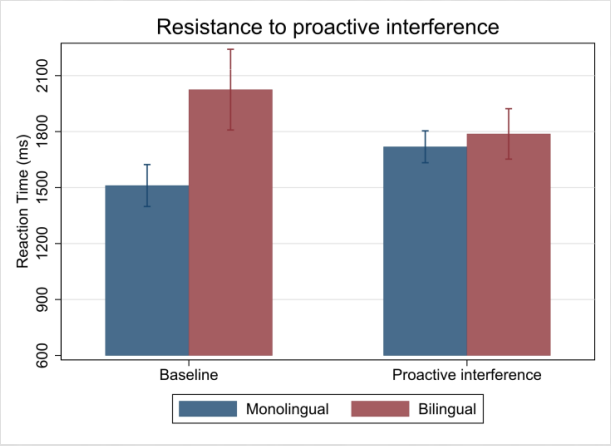
- Speed of processing beyond the baseline:
  - With each repetition in the implicit learning task, bilingual children showed larger improvement in RT than their peers;
  - The interference cost in RT is larger for the monolingual children;
  - The tone condition in the performance monitoring task resulted in improved RT in monolingual children only.
- Significant correlations:
  - More balanced bilingual children showed more efficient implicit learning;
  - More efficient learners showed smaller intrusion costs in PI;
  - More efficient learners showed greater post error slowing, better monitoring skills.

COMMON PATTERNS: PI

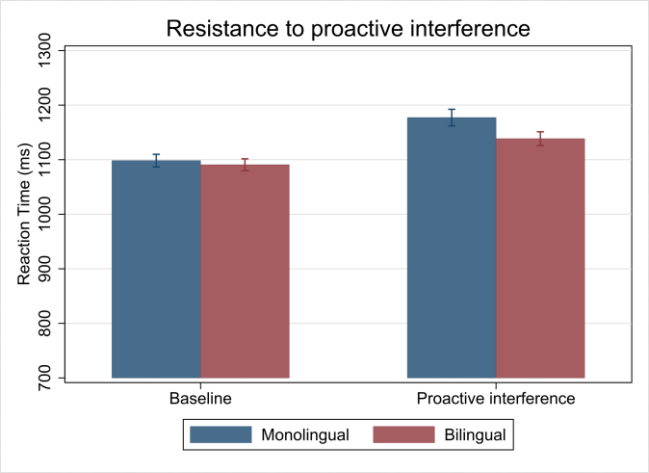
English speaking children



Hu-Ro speaking children



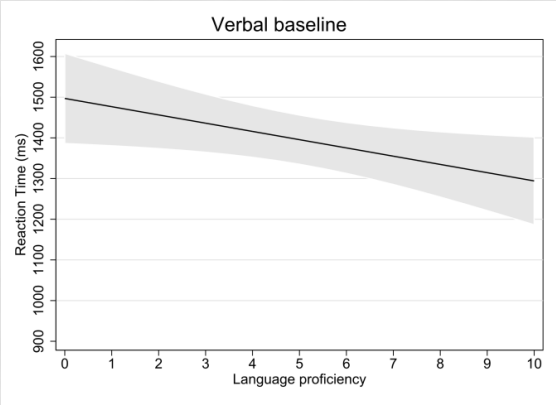
English speaking young adults



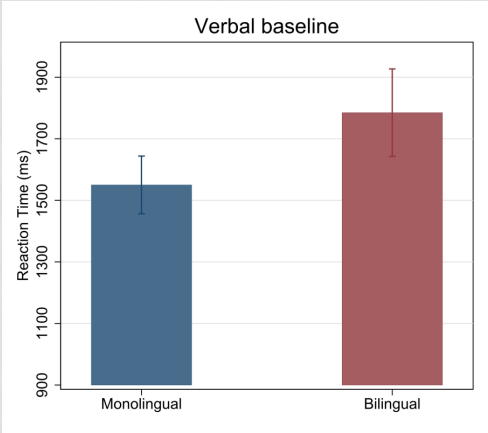
- Resistance to proactive interference:
  - Interference affects everyone's performance negatively;
  - Bilingual individuals are more efficient in resisting interference than their monolingual peers;
  - the pattern is independent of age, environment, SES, culture;
  - Resistance to PI shows positive correlation with language proficiency.

CONFLICTING RESULTS
VERBAL BASELINE

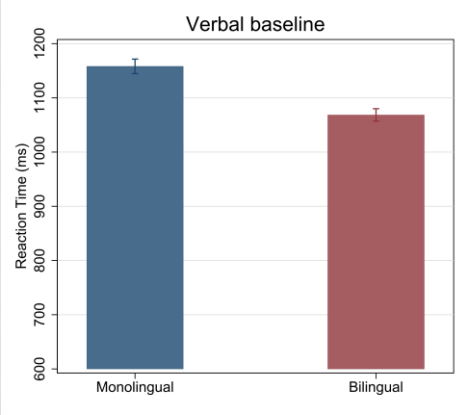
English speaking children



Hu-Ro speaking children



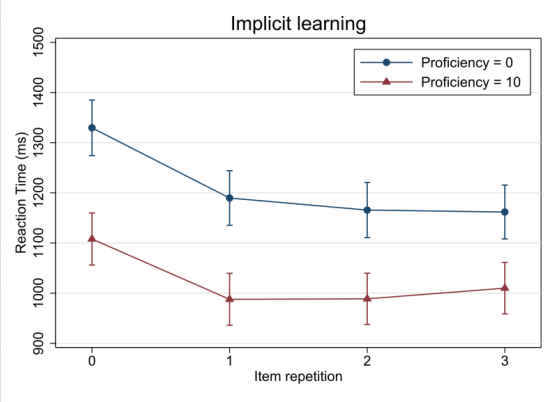
English speaking young adults



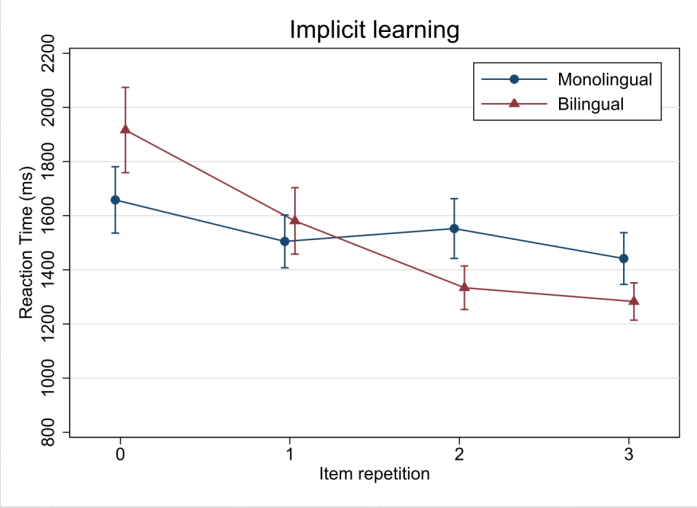
Verbal baseline may be affected by language context;

Implicit learning

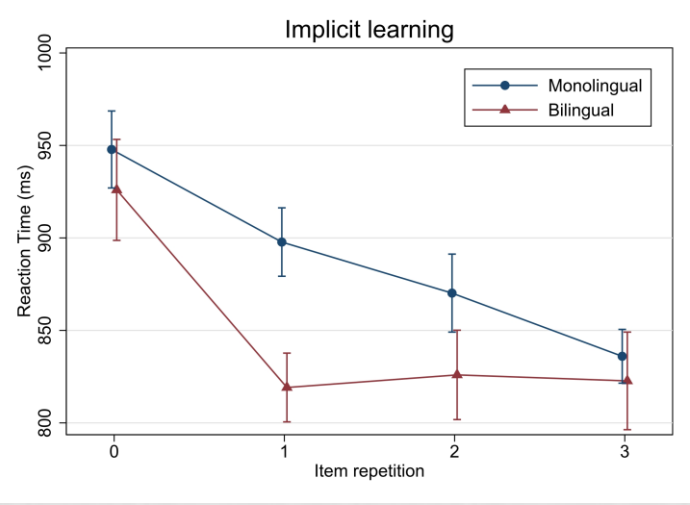
English speaking children



Hu-Ro speaking children



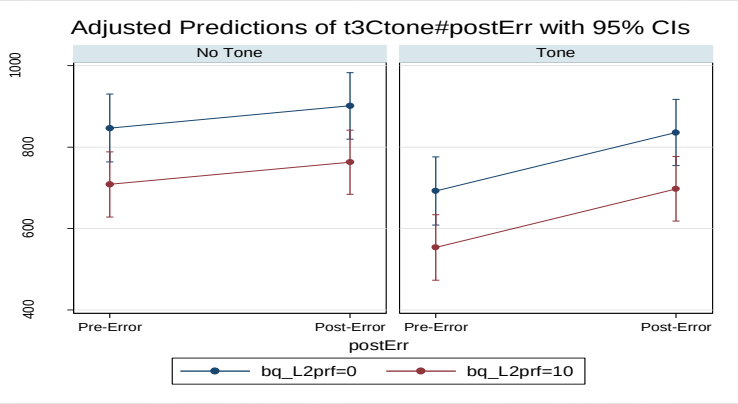
English speaking young adults



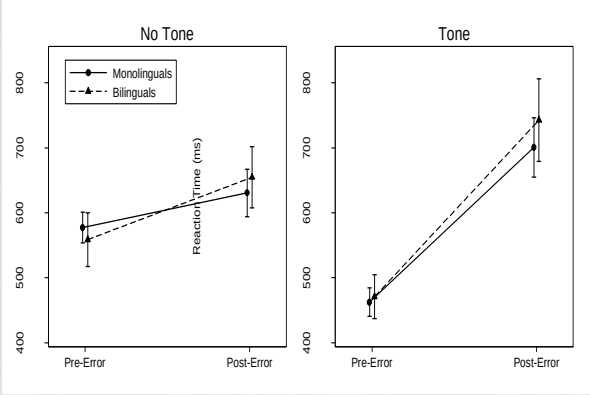
- Implicit learning:
  - Overall speed of processing advantage in bilingual participants;
  - Learning curves: mixed in children, steeper in adults;
- Implicit learning rate is correlated with resistance to interference and error monitoring.

PERFORMANCE MONITORING

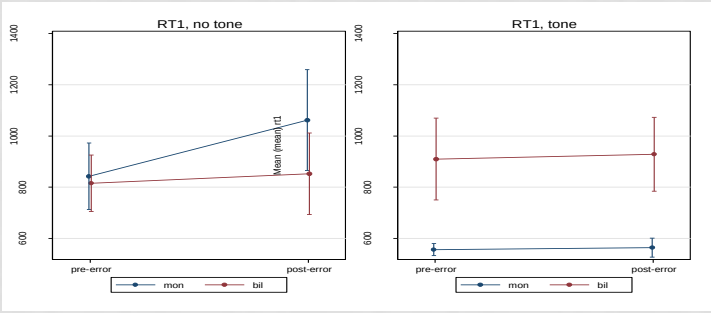
English speaking children



English speaking young adults



Hu-Ro speaking children



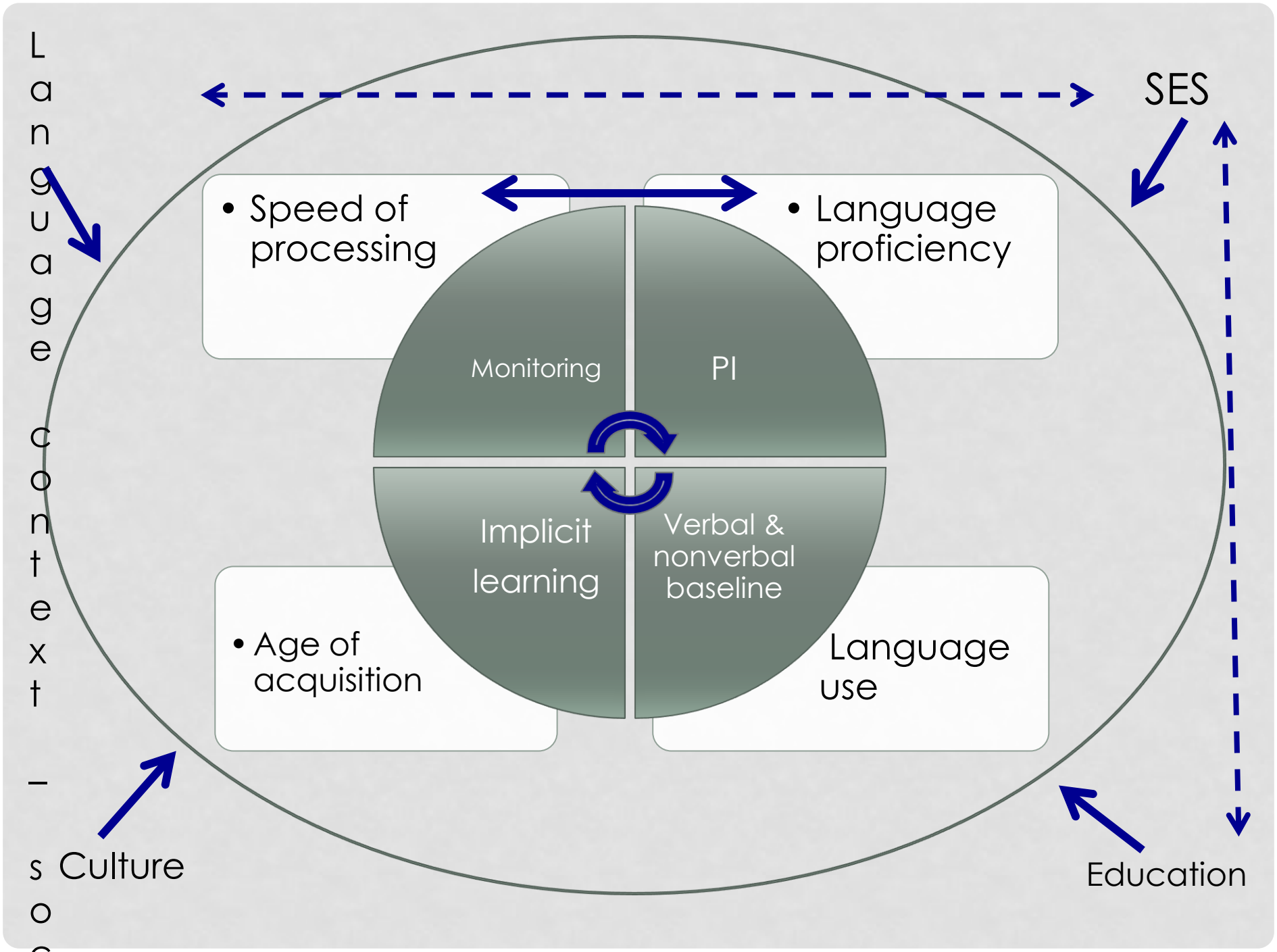
Similar pattern of performance between monolingual and bilingual groups.

CONCLUSIONS

- As suggested by different theoretical models (e.g. Miyake et al., 2000), EFs are independent functions but interact with each other and they also interact with various language factors.

- EFs show a relationship with language proficiency. More proficient bilingual participants showed more efficient executive control, e.g., steeper learning curves and smaller intrusion costs.

- Proficiency is not the only language factor that shows an association with executive control: language use and language context are also related.
- There is a bilingual advantage in resistance to proactive interference across age groups and languages.
- A global processing speed advantage is present in most EF tasks for the bilingual participants.


Language context – soc
SES
• Speed of processing
• Language proficiency
Monitoring
PI
Implicit learning
Verbal & nonverbal baseline
• Age of acquisition
Language use
Culture
Education

FUTURE

- Examine resistance to proactive interference in linguistically more complex task.
- Balanced bilingual children are typically faster than less proficient or monolingual peers and they are also more efficient on several EF tasks. Is efficiency primarily related to speed of processing or language proficiency?
- Highly proficient bilingual children show steeper learning curves than their peers. What makes them better learners?
- How are language proficiency, language use, and language context related to each other and to specific executive components?
- ……

THANK YOU!

KMARTON@GC.CUNY.EDU