Domain general vs. domain specific language and cognitive processing in bilingual aphasia

BOSTON UNIVERSITY

Teresa Gray and Swathi Kiran

Aphasia Research Laboratory, Boston University

BOSTON UNIVERSITY

INTRODUCTION

Bilinguals routinely manage (i.e., control) two languages, but how this skill effects cognitive control is under debate:

- an **association** between language control (LC) and cognitive control (CC) vs. a **dissociation** between these control mechanisms (e.g., Calabria et al., 2011; Prior & Gollan, 2011).

Current study:

- Bilingual adults with aphasia (BAA) offer a unique opportunity to explore the relationship between LC and CC because they are often reported to present with LC deficits. Few studies have investigated LC and CC mechanisms in this population (Dash & Kar, 2014; Gray & Kiran, in press; Green et al., 2010; Verreyt et al., 2013).

OBJECTIVES

1. Determine whether deficits in language inhibition are specific to the language domain or are indicative of a more general cognitive deficit.

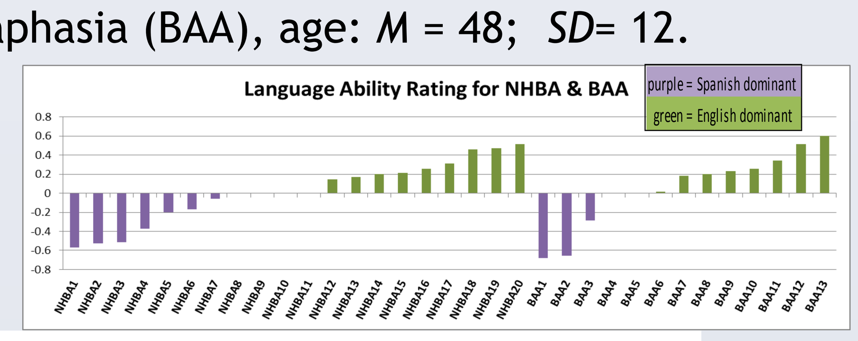
Similarity between language control and cognitive control:	
Bilingual Language Processing	Resistance to Distractor Interference (type of cognitive control)
Both languages are active. To access the target language, the non-target language must be inhibited.	Inhibition of non-target stimuli that is simultaneously presented with the target stimuli.

2. Determine if there is an effect of task complexity.

PARTICIPANTS

- 20 Spanish-English neurologically healthy bilingual adults (NHBA), age: M = 51; SD= 13.
- 13 Spanish-English bilingual adults with aphasia (BAA), age: M = 48; SD= 12.

*NHBA and BAA were matched on age and education and all filled out the Language Use Questionnaire (Kiran et al., 2010).



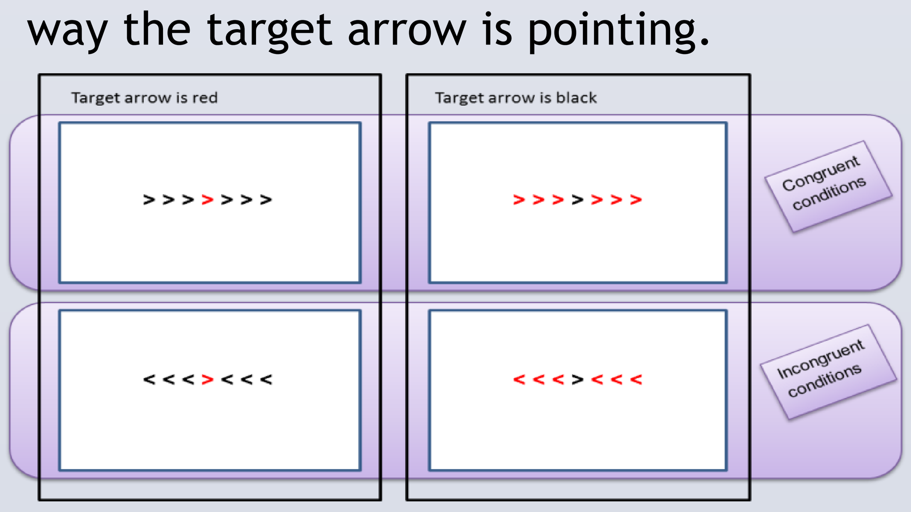
Diagnostic testing in English and Spanish for all BAA.

Standardized Tests	BAA1 E	BAA1 S	BAA2 E	BAA2 S	BAA3 E	BAA3 S	BAA4 E	BAA4 S	BAA5 E	BAA5 S	BAA6 E	BAA6 S	BAA7 E	BAA7 S	BAA8 E	BAA8 S	BAA9 E	BAA9 S	BAA10 E	BAA10 S	BAA11 E	BAA11 S	BAA12 E	BAA12 S	BAA13 E	BAA13 S
BAT																										
Receptive Language	36%	14%	67%	88%	75%	74%	75%	68%	18%	63%	44%	54%	89%	67%	98%	85%	47%	70%	88%	75%	25%	17%	95%	98%	91%	46%
Expressive Language	80%	0%	80%	100%	100%	35%	DNT	DNT	DNT	80%	DNT	DNT	100%	65%	100%	75%	65%	70%	100%	95%	0%	0%	100%	100%	100%	10%
BAT Part C Translation	into S	into E	into S	into E	into S	into E	into S	into E	into S	into E	into S	into E	into S	into E	into S	into E	into S	into E	into S	into E	into S	into E	into S	into E	into S	into E
Translation	20%	30%	75%	85%	45%	65%	50%	85%	35%	30%	30%	20%	60%	80%	55%	80%	55%	70%	100%	95%	40%	0%	100%	100%	55%	75%
Boston Naming Test																										
Expressive Language	0%	0%	53%	57%	57%	10%	38%	13%	0%	23%	0%	0%	63%	8%	82%	25%	15%	18%	65%	50%	0%	0%	80%	70%	100%	8%
PALPA (25) /EPLA (26)																										
	93%	refused	72%	78%	69%	58%	65%	70%	DNT	74%	62%	74%	93%	66%	100%	98%	71%	89%	95%	85%	63%	57%	94%	94%	95%	63%
PPT-picture version																										
	83%		90%		92%		94%		50%		90%		88%		98%		63%		85%		52%		96%		96%	
CLQT Cognitive Domains																										
attention	DNT		DNT		DNT		Mild		Severe		Mild		Moderate		WNL		WNL		Mild		Severe		WNL		WNL	
memory	DNT		DNT		DNT		Moderate		Severe		Severe		WNL		WNL		Moderate		Severe		Severe		WNL		WNL	
executive functions	DNT		DNT		DNT		WNL		Severe		Severe		WNL		WNL		Mild		Severe		Severe		WNL		WNL	
language	DNT		DNT		DNT		Mild		Severe		Severe		WNL		WNL		WNL		Mild		Severe		WNL		WNL	
visuospatial skills	DNT		DNT		DNT		WNL		Severe		Mild		Mild		WNL		WNL		Mild		Severe		WNL		WNL	
composite severity	DNT		DNT		DNT		Mild		Severe		Moderate		Mild		WNL		Mild		Moderate		Severe		WNL		WNL	
clock drawing	DNT		DNT		DNT		Mild		Severe		Mild		WNL		WNL		WNL		WNL		Severe		WNL		WNL	
CLQT Subtests																										
Symbol Cancelation	WNL		WNL		WNL		not WNL		not WNL		WNL		not WNL		WNL		WNL		WNL		not WNL		WNL		WNL	
Symbol Trails	not WNL		not WNL		WNL		not WNL		not WNL		not WNL		WNL		WNL		WNL		not WNL		not WNL		WNL		WNL	
Design Generation	not WNL		not WNL		not WNL		WNL		not WNL		not WNL		not WNL		WNL		not WNL		not WNL		not WNL		WNL		WNL	

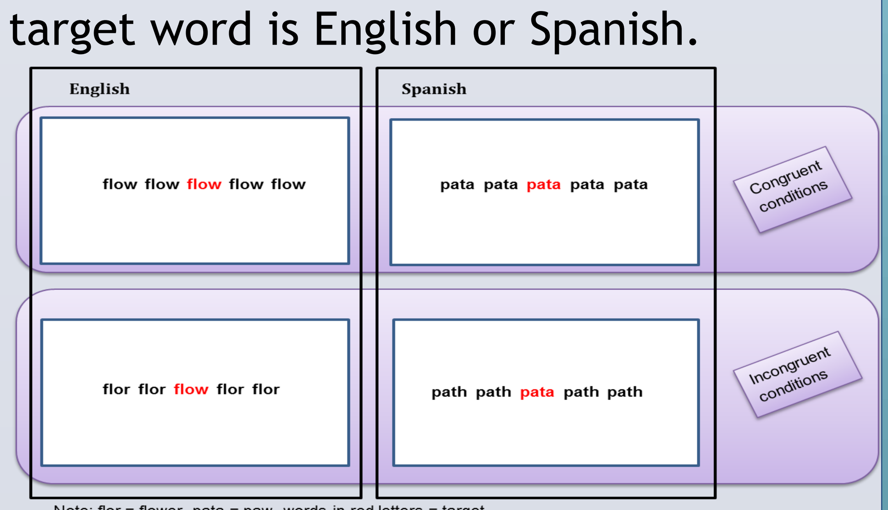
Note: BAT = Bilingual Aphasia Test, Receptive Language = average of Pointing, Semi-complex commands, Complex commands, Verbal auditory discrimination, semantic categories, synonyms, antonyms I & II, Semantic acceptability subtests; Expressive Langauge = object naming, Expressive Language = BNT in English and Spanish; PALPA 25 = Imageability and Frequency Visual Lexical Decision 25 on the Psycholinguistic Assessments of Language Processing in Aphasia, and the Spanish translation, EPLA 26 = Decisión lexica visual: imaginabilidad y frecuencia 26 on la Evaluación del Procesamiento Lingüístico en la Afasia, PPT = Pyramids and Palm Trees Test, CLQT: Cognitive LInguistic Quick Test, into S = translating from English into Spanish, into E = translating into English from Spanish, DNT = did not test, WNL = within normal limits.

METHODS

1. Non-linguistic Flanker: decide which way the target arrow is pointing.

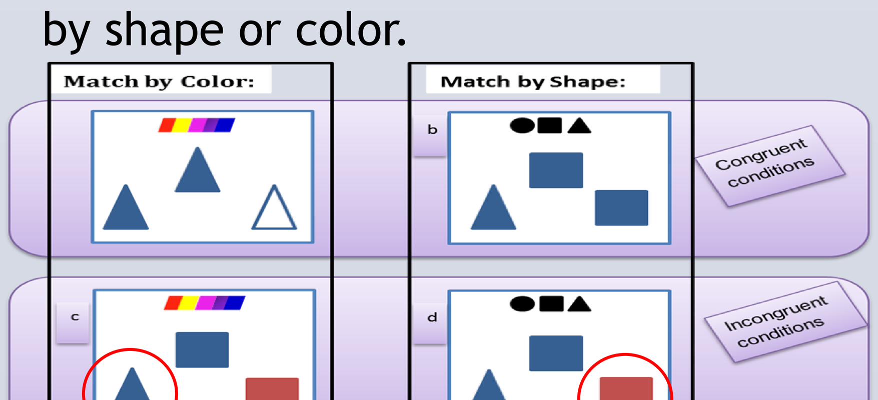


2. Linguistic Flanker: decide if the target word is English or Spanish.

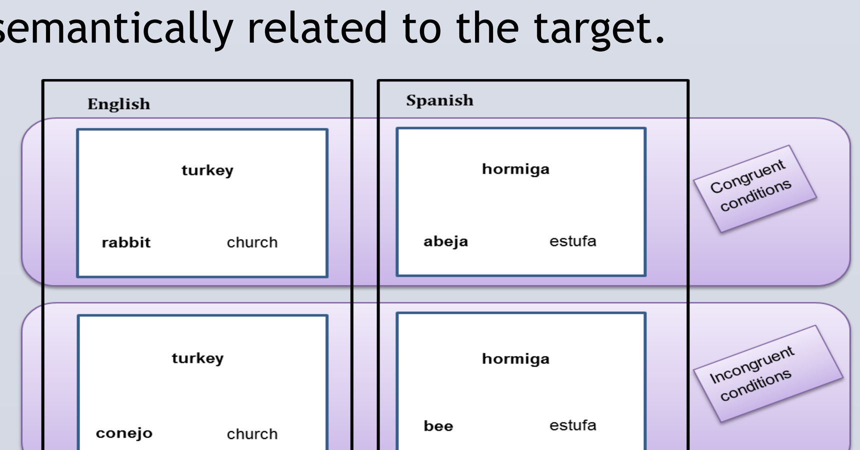


Note: flor = flower, pata = paw, words in red letters = target.

3. Non-linguistic Triad: select the response that matches the target by shape or color.



4. Linguistic Triad: select the word that is semantically related to the target.



Note: hormiga = ant, conejo = rabbit, abeja = bee, estufa = stove, bold text = word-pair.

HYPOTHESES

Task	Potential Outcomes: Domain General Cognitive Control		Domain Specific Cognitive Control		Effects of Task Complexity	
Non-linguistic Flanker	✓	X	✓	X	✓	X
Non-linguistic Triad	✓	X	✓	X	X	✓
Linguistic Flanker	✓	X	X	✓	✓	X
Linguistic Triad	✓	X	X	✓	X	✓

These outcomes should be identified in accuracy and/or latency for NHBA and BAA.

Note: the congruency effect is notated by a ✓; no congruency effect is notated by an X.

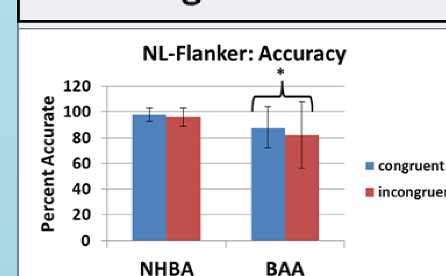
RESULTS

Analyses:

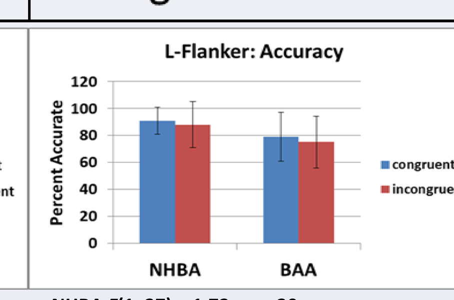
1. Congruency effect: indicates that control mechanisms are functioning in that domain. Formula: accuracy: (congruent - incongruent); RT: (incongruent - congruent).

- **Non-linguistic tasks:** two-way ANOVAs were performed to evaluate the effect of condition (congruent and incongruent) x target (color and shape *or* red and black) for percent accuracy and zRT for NHBA and BAA.
- **Linguistic tasks:** two-way ANCOVAs were performed to evaluate the effect of condition (congruent and incongruent) x target (English and Spanish) for percent accuracy and RT for NHBA and BAA and a measure of language experience was the covariate.

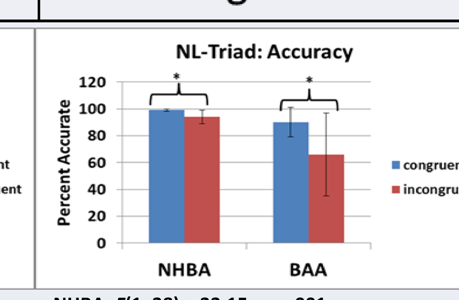
Non-linguistic Flanker	Linguistic Flanker	Non-linguistic Triad	Linguistic Triad



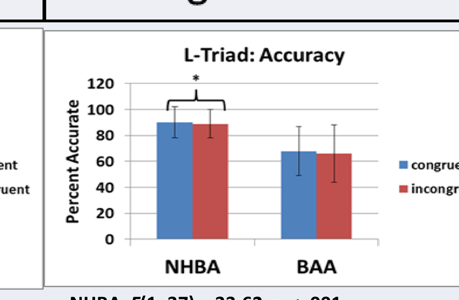
NHBA: $F(1, 38) = 1.47$, $p = .23$; BAA: $F(1, 24) = 4.29$, $p < .05$



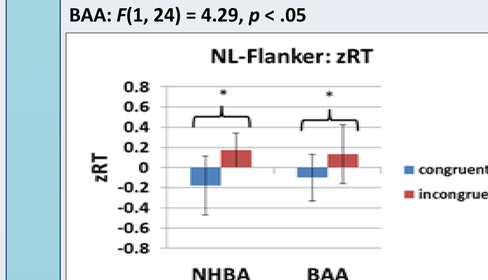
NHBA $F(1, 37) = 1.72$, $p = .20$; BAA $F(1, 23) = .85$, $p = .37$)



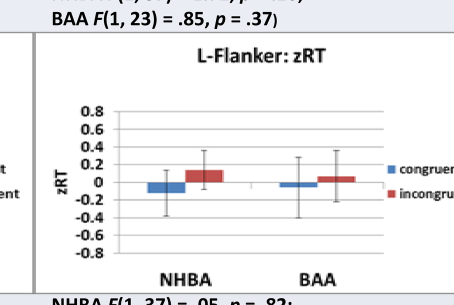
NHBA: $F(1, 38) = 33.15$, $p < .001$; BAA: $F(1, 24) = 22.15$, $p < .001$



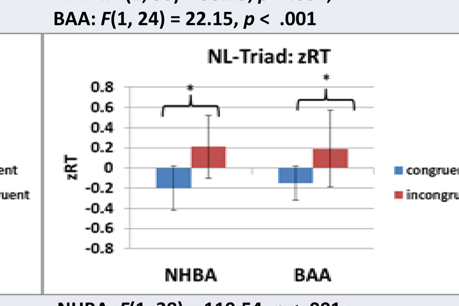
NHBA $F(1, 37) = 33.62$, $p < .001$; BAA $F(1, 23) = 2.05$, $p = .17$



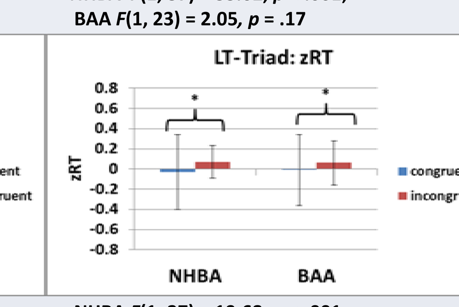
NHBA: $F(1, 38) = 34.82$, $p < .001$; BAA: ($F(1, 24) = 8.12$, $p < .01$



NHBA $F(1, 37) = .05$, $p = .82$; BAA $F(1, 23) = .07$, $p = .79$)

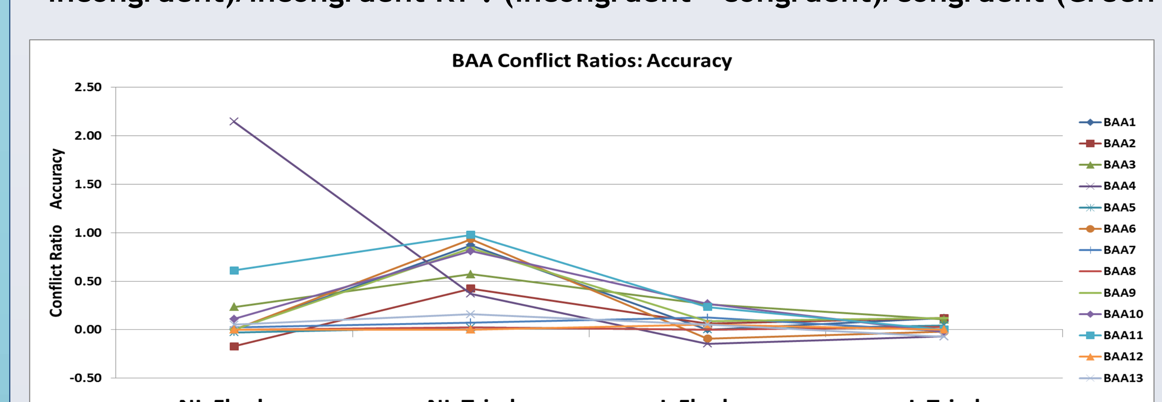


NHBA: $F(1, 38) = 119.54$, $p < .001$; BAA $F(1, 24) = 15.98$, $p < .001$)



NHBA $F(1, 37) = 19.68$, $p < .001$; BAA $F(1, 23) = 3.54$, $p = .07$)

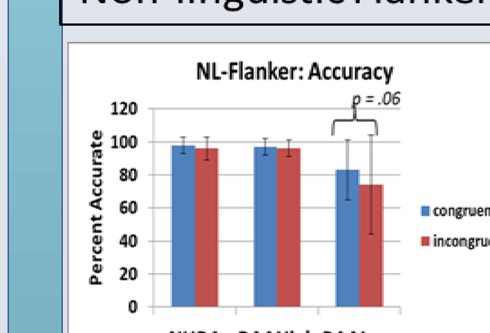
2. Conflict Ratio: indicates the magnitude of conflict. Formula: accuracy: (congruent-incongruent)/incongruent RT : (incongruent - congruent)/congruent (Green et al. (2010).



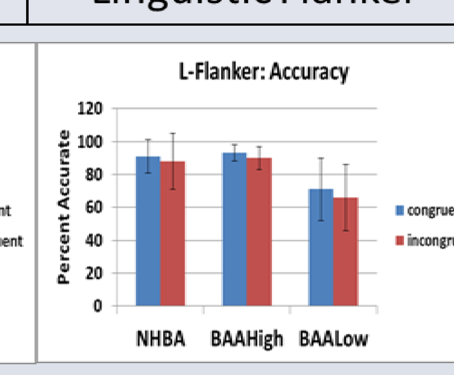
BAAHigh (higher dx scores): BAA3, BAA7, BAA8, BAA12, BAA13

BAALow (lower dx scores): BAA1, BAA2, BAA4, BAA5, BAA6, BAA9, BAA10, BAA11

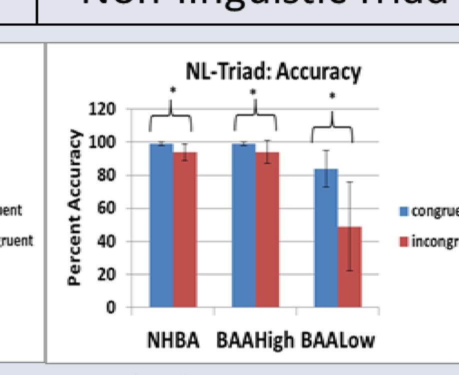
Non-linguistic Flanker	Linguistic Flanker	Non-linguistic Triad	Linguistic Triad



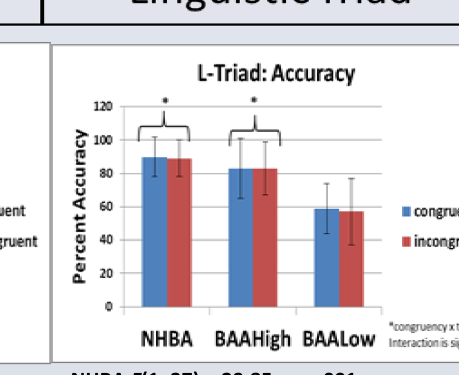
NHBA: $F(1, 38) = 1.47$, $p = .23$; BAAHigh: $F(1, 8) = .80$, $p = .40$; BAALow: $F(1, 14) = 4.04$, $p = .06$



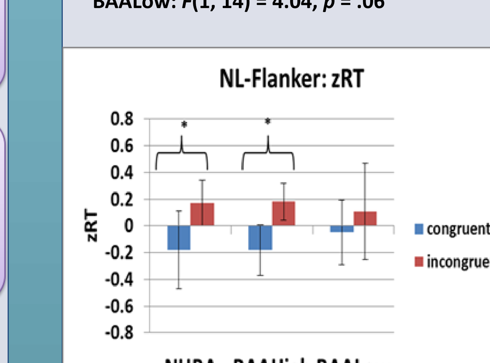
NHBA $F(1, 37) = 1.72$, $p = .20$; BAAHigh $F(1, 7) = 1.37$, $p = .28$; BAALow $F(1, 13) = 1.55$, $p = .23$



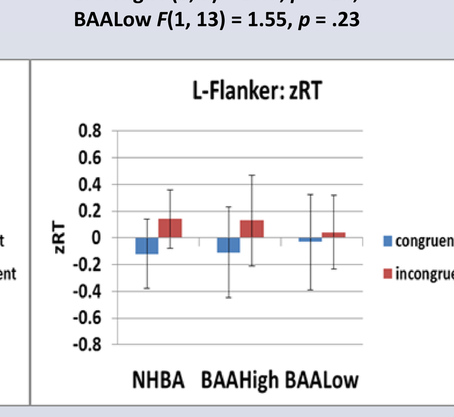
NHBA: $F(1, 38) = 33.15$, $p < .001$; BAAHigh: $F(1, 8) = 5.55$, $p < .05$; BAALow: $F(1, 14) = 41.74$, $p < .001$



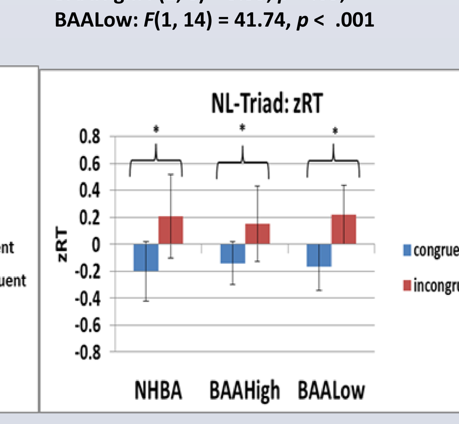
NHBA $F(1, 37) = 29.85$, $p < .001$; BAAHigh $F(1, 7) = 7.9$, $p < .05$; BAALow $F(1, 13) = .54$, $p = .48$



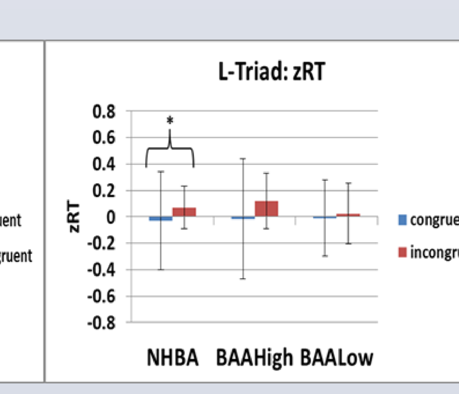
NHBA: $F(1, 38) = 34.82$, $p < .001$; BAAHigh: $F(1, 8) = 20.88$, $p < .01$; BAALow: $F(1, 14) = 1.60$, $p = .103$



NHBA $F(1, 37) = .05$, $p = .82$; BAAHigh $F(1, 7) = 3.05$, $p = .12$; BAALow $F(1, 13) = 1.78$, $p = .21$



NHBA: $F(1, 38) = 119.54$, $p < .001$; BAAHigh: $F(1, 8) = 31.77$, $p < .001$; BAALow: $F(1, 14) = 7.57$, $p < .05$



NHBA $F(1, 37) = 19.68$, $p < .001$; BAAHigh $F(1, 7) = .51$, $p = .505$; BAALow $F(1, 13) = .485$, $p = .50$

Congruency checklist for all tasks for NHBA, BAAHigh and BAALow.

Task	NHBA (n = 20) acc	NHBA (n = 20) RT	BAA (n = 13) acc	BAA (n = 13) RT	BAAHigh (n = 5) acc	BAAHigh (n = 5) RT	BAALow (n = 8) acc	BAALow (n = 8) RT
Non-linguistic Flanker	X	✓	✓	✓	X	✓	✓	X
Linguistic Flanker LExperience.cov	X	X	X	X	X	X	X	X
Non-linguistic Triad	✓	✓	✓	✓	✓	✓	✓	✓
Linguistic Triad LExperience.cov	✓	✓	X	✓	✓	✓	X	X

Note: The congruency effect is notated by a ✓; no congruency effect is notated by an X, NHBA = neurologically healthy adults, BAAHigh = bilingual adults with high diagnostic scores, BAALow = bilingual adults with aphasia iwth low diagnostic scores, LExperience.cov = language experience cov = covariate.

CONCLUSIONS

1. NHBA (and BAAHigh) → Domain General Cognitive Control
2. BAALow → Domain Specific Cognitive Control
3. BAAHigh vs BAALow: separable patient groups