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Research Question

Does L2 intensive learning improve performance in the Eriksen Flanker Task?

Introduction

- Some studies show bilingual advantage in The Eriksen Flanker Task [e.g. 1,3].
- There are 2 indices of cognitive control in the Flanker Task:
 - conflict monitoring (indexed by overall RTs),
 - inhibition of interference (indexed by incongruent - congruent Rts).
- The fronto-central N2 (200-300 ms post-stilumus peaking at Fcz) observed in the Flanker Task interpreted as an index of inhibition [2].
- Consequences of intensive L2 learning: better results in tasks measuring various aspects of cognitive control [4].

Methods

Longitudinal study

The three testing times with 7-month breaks between (T1, T2, T3)

Participants
- Experimental group: intensive exposure to L2, content lessons in L2 & L1 (n=28, age=18 y.o., nb of L2 lessons=12)
- Control group: content lessons only in L1; L2 taught only as a foreign language (n=24, age=18 y.o., nb of L2 lessons=4)

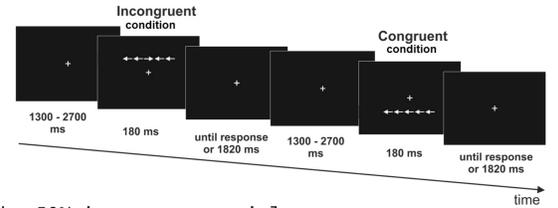
Task structure

Respond to the direction of the central arrow

Ignore the distractors (Flanking arrows)

2 blocks, 72 trials in each, 50% incongruent trials

Battery of linguistic tasks and cognitive tasks, e.g. Flanker Task



Main results

Behavioral results

Design

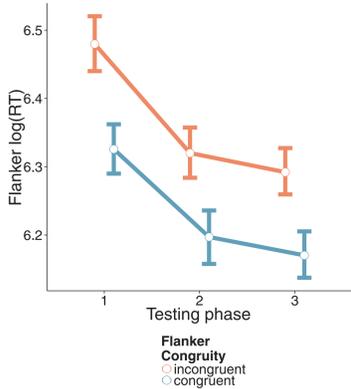
Dependent variables:

- Index of inhibition = flanker congruity effect (incongruent - congruent RT)
- Index of conflict monitoring = overall RT

Controlled variables: - IQ (Raven),
- L2 proficiency (LexTale vocabulary test)

Results

Repeated Measures ANOVA
2 x (Congruency) x 3 (Testing Time)
x 2 (Group) x 2 (IQ) x 2 (Lextale)



- Main effect of congruity: Rts: congruent < incongruent (p<.001).
- Better performance at T2&T3 than at T1: shorter RTs (p<.001).
- No differences between groups + no influence of Group, IQ, L2 proficiency.

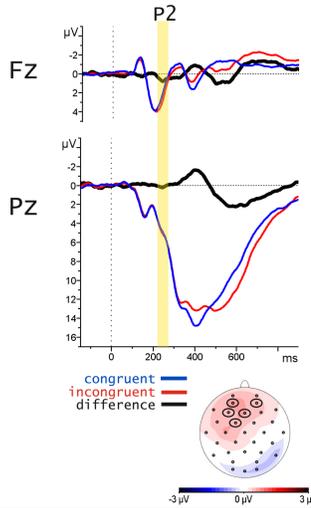
ERP index of inhibition

Design

Dependent variable:

the N2 effect (mean amplitude in uV for incongruent - congruent in 220-280 ms time window)

Results



- We expected the N2 effect (peaking at FCz) indexing inhibition in the INC condition.
 - Instead, we obtained a P2 modulation (peaking at AF3) in the 220-280 ms time-window.
- The amplitude of the P2 effect was not modulated by:
- Testing Session,
 - IQ (Raven),
 - L1 or L2 proficiency (Lextale).

The INC condition engages more selective attention but does not engage more inhibition

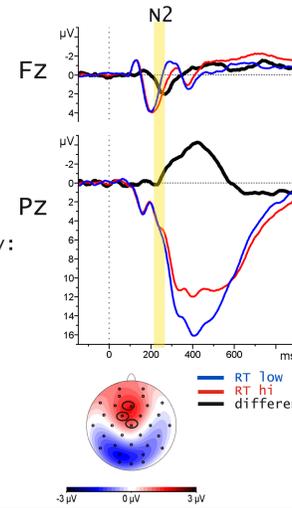
ERP index of conflict monitoring?

Design

Dependent variable:

the N2 effect (mean amplitude in uV in 220-280 ms time window)

Results



- Surprisingly, we observed greater N2 effect (peaking at FCz) for faster participants in the 220-280 ms time-window.
- The N2 is described as an index of conflict monitoring.

Greater N2 negativity = more cognitive control
↓
faster RTs?

Further exploratory analyses

If overall RTs index some aspect of cognitive control, what makes some participants faster or slower?

Using mixed-effects models we tested what best predict Rts:

- * Group (control, experimental),
- * Testing time,
- * Flanker congruity,
- * Mean reaction accuracy

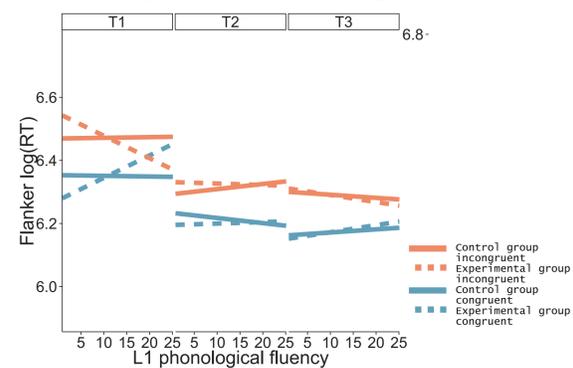
and L1/L2 proficiency measures:

- * L1 and L2 LexTale score,
- * L1 and L2 phonological fluency,
- * L1 and L2 semantic fluency,
- * RTs in L1 and L2 picture naming,
- * Raven (IQ);

Below are the results of the best fitting model:

	Estimate	Std. Error	t value
(Intercept)	6.30	0.02	371.66
Accuracy	-0.38	0.09	-4.17
Congruity	0.11	0.01	14.91
test2.vs.avg	-0.15	0.02	-9.63
test3.vs.avg	-0.18	0.01	-12.28
Congruity:F1.Phon.L1	0.00	0.00	-3.01
Accuracy:Congruity	0.25	0.13	2.01
Congruity:F1.Phon.L1:Group	-0.01	0.00	-3.48
Congruity:T2.vs.avg:Group	0.05	0.02	3.01
Congruity:T3.vs.avg:Group	0.01	0.01	0.83
Congruity:T2.vs.avg:F1.Phon.L1	0.01	0.00	3.82
Congruity:T3.vs.avg:F1.Phon.L1	0.00	0.00	1.99
Accuracy:Congruity:T2.vs.avg	-0.37	0.21	-1.75
Accuracy:Congruity:T3.vs.avg	-0.39	0.19	-2.09
Congruity:T2.vs.avg:F1.Phon.L1:Group	0.01	0.00	2.77
Congruity:T3.vs.avg:F1.Phon.L1:Group	0.01	0.00	3.48

Flanker log(RT) ~ L1 phonological fluency



Only in the experimental group:

- * the higher phonological fluency, the smaller congruity effect in RTs
- * RTs in incongruent condition get faster, RTs in congruent condition get slower.

Discussion

- Congruent and incongruent trials: differential engagement of selective attention (as indexed by P2).
- Efficiency of performance (overall RTs) associated with greater conflict monitoring ability (as indexed by N2).
- No straightforward impact of L2 intensive learning.
- However, further exploratory analyses show a complex pattern of interactions:
 - The better cognitive control (as indicated by L1 verbal fluency), the smaller flanker interference, but only in the experimental group.
- Tentative speculation:
 - Intensive L2 learning enables flexible adjustments to task demands;
 - Possible strategy: focus on central arrow, ignore the flankers (leads to longer RTs on congruent trials, but helps avoid interference in incongruent trials).

References

- [1] Costa, A., Hernández, M., Costa-Faidella, J., & Sebastián-Gallés, N. (2009). On the bilingual advantage in conflict processing: Now you see it, now you don't. *Cognition*, 113(2), 135-149.
- [2] Folstein, J. R., & Van Petten, C. (2008). Influence of cognitive control and mismatch on the N2 component of the ERP: a review. *Psychophysiology*, 45(1), 152-170.
- [3] Kroll, J. F., Dussias, P. E., Bogulski, C. A., & Kroff, J. R. V. (2012). Juggling Two Languages in One Mind. *Psychology of Learning and Motivation*, 56, 229-262.
- [4] Sullivan, M. D., Janus, M., Moreno, S., Astheimer, L., & Bialystok, E. (2014). Early stage second-language learning improves executive control: Evidence from ERP. *Brain and Language*, 139, 84-98.

Acknowledgements

The research was supported by Foundation for Polish Science Subsidy, National Science Centre grant awarded to Zofia Wodniecka and Ministry of Science and Higher Education grant awarded to Patrycja Kałamała. We are grateful to the participants, who volunteered to take part in our study and all members of Langusta who helped to prepare and conduct the study.