Congruency Effects and Individual Differences in Bilingual Experience Influence Simon Task Performance

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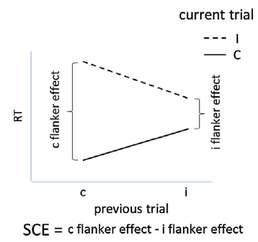
INTRODUCTION

Simon Takes Control

- **Simon effect**
  - Reflects *cognitive control* ('set of fluid operations that enable intentional processing and adaptive cognitive performance', Craik & Bialystok, 2006)
  - Faster responses to stimuli located on the same side of the required keypress (congruent) and slower to stimuli on the opposite side (incongruent) (Craft & Simon, 1970)
  - Mean RT Incongruent - Mean RT Congruent = Simon effect (bigger = less cognitive control)

- **Sequential Congruency Effect**
  - Reflects *speed of disengagement of attention* from previous trial information (see Egner, 2014)
  - Simon effect is larger after congruent trials, smaller after incongruent trials, intermediate after neutral trials (Aisenberg & Henik, 2010)
  - Bigger SCE = slow disengagement of attention from previous trial



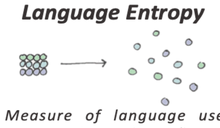
SCE = c flanker effect - i flanker effect

Bilinguals out of Control

- Long-standing debate over the link between bilingualism and cognitive control (see Grundy et al. 2017 for a review)
- **Grundy et al. (2017)**: no differences in size of Simon effect but smaller SCE in bilinguals vs. monolinguals > better disengagement of attention
- **Goldsmith & Morton (2018)**: no differences in SCE in bilinguals vs. monolinguals

- **Gullifer et al. (2018):** diversity in social language use in daily life related to connectivity ACC and putamen and linked to control and context monitoring

Language Entropy



Measure of language use across various spheres (home, school, work, social) calculated using Shannon's Entropy.

$$H(X) = -\sum_{i=1}^{n} p(x_i) \log p(x_i)$$

RESEARCH QUESTION

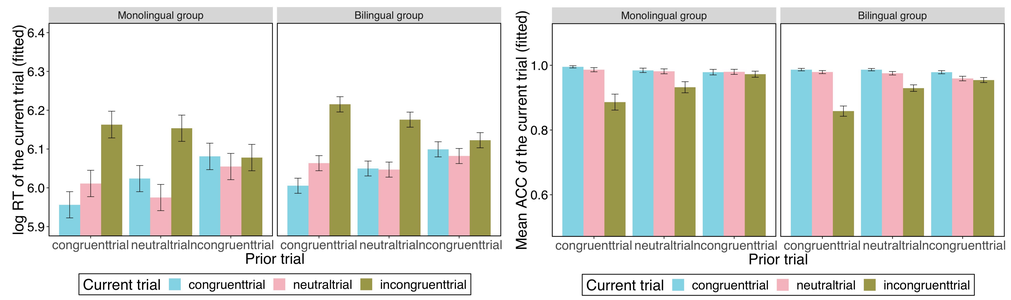
- **Does bilingual language experience, including language entropy/diversity, modulate the Sequential Congruency Effect?**

RESULTS

Error bars are +/- 1 SEM

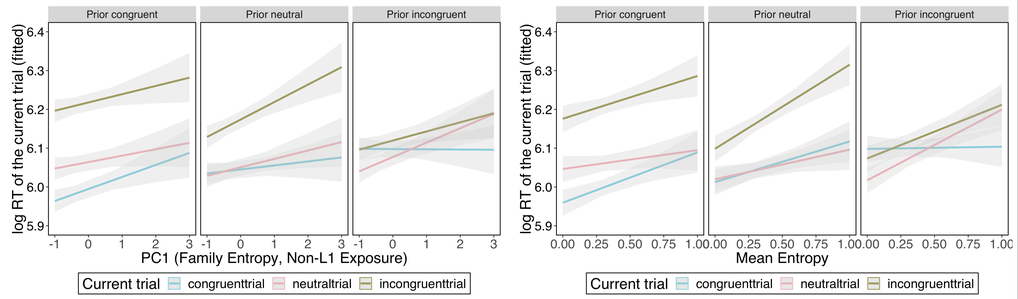
SIMON EFFECT (current trial only)

	Simon effect (ms)
Monolinguals	51
Bilinguals	57



SCE (prior trial*current trial)

	SCE (ms)
Monolinguals	113
Bilinguals	77
Bilinguals with low PC1	116
Bilinguals with high PC1	78
Bilinguals with low mean Entropy	100
Bilinguals with high mean Entropy	52

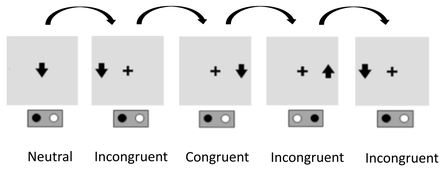


METHODS

TASK

- **Nonlinguistic Simon Task**
  - Types of trials

  - Prior trial effects



(9 possible combinations)

PARTICIPANTS

- N = 85 (64 bilinguals, 21 monolinguals)
- Language History Questionnaire (adapted LEAP-Q, 2007)

Characteristics (bilinguals)	Mean	SD	Range
L2 AoA (years)	5.55	4.49	0-22
Time speaking non-L1 (%)	28.1	27.29	0-90
Work Entropy	0.31	0.38	0-1.29
Friends Entropy	0.31	0.38	0-1.29
Class Entropy	0.39	0.39	0-1.00
Family Entropy	0.22	0.33	0-1.16
Mean Entropy	0.36	0.30	0-1.12
Language Mixing (1-7)	3.37	1.60	1-7

INDIVIDUAL DIFFERENCES MEASURES

- Monolingual vs. Bilingual
- Mean entropy (across all social contexts)
- Family Entropy/Time speaking non-L1 (PC1)
- L2 AoA (PC2)
- Work/Friends/Class entropy (PC3)

MODELS (lme4)

- RT ~prior trial*current trial*individual difference
- ACC ~prior trial*current trial*individual difference

SUMMARY & CONCLUSIONS

SUMMARY

- **General results**
  - Similar Simon effect sizes across bilinguals and monolinguals
  - Similar SCE sizes across bilinguals and monolinguals

- **Differences among bilinguals**:
  - High language diversity in family contexts/%age of non-L1 exposure = smaller SCE
  - High language diversity in social contexts in general = smaller SCE
  - No effect of L2 AoA on SCE
  - No effect of language mixing

CONCLUSIONS

- **Does bilingual language experience, including language entropy/diversity, modulate the Sequential Congruency Effect?**
- Short answer: Yes, to some degree…
- Long answer:
  - It is not bilingualism per se, but language diversity within social contexts that is associated with smaller Sequential Congruency Effects
  - Bilinguals with high language diversity within social contexts were better at monitoring and disengagement of attention from prior trial
  - Bilinguals with low language diversity within social contexts and monolinguals were slower at disengaging attention from prior trial
  - These effects were independent from L2 AoA
  - Results consistent with the theoretical view that bilinguals constantly monitor and inhibit the non-target language (Bialystok et al., 2009)
  - Results consistent with empirical evidence (Grundy et al., 2017, but not Goldsmith & Morton, 2018)

- *Characterizing the bilingual experience might open novel avenues to understand the complex relationships between bilingualism and general cognitive capacities.*

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