

Code-switching during composition: MEG evidence from Korean-English bilinguals

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Background

Intra-sentential code-switching involves composing elements from two (or more) languages together

- Effects of composition, peaking at ~225 ms in the LATL, have been found for English^[1] as well
 as in Arabic^[2] and ASL^[3]
- The ACC and dIPFC, regions associated with executive control, have been implicated in artificial language switching tasks^[4]
- Artificial language switching tasks typically involve switching languages between elements that do not compose; while work using naturalistic code-switching typically involve combining complex elements^[5]

Research Questions

How does switching languages during composition affect processing mechanisms incrementally?

- Do composition effects for English replicate among Korean-English bilinguals?
- Are composition effects also observable for Korean?
- Are composition effects observable even when the language switches between the composing elements?
- Are executive control regions (dIPFC, ACC)
 recruited when the language switches? And if so, is
 this observable whether composition occurs?

Methods

20 Korean-English Bilingual Adults (16 Female, 4 Male)

- Age: M = 25.60 years (SD = 8.44 years)
- Age of Acquisition (Korean): M = 0.60 years (SD = 0.99 years)
- Age of Acquisition (English): M = 6.45 years (SD = 4.89 years)

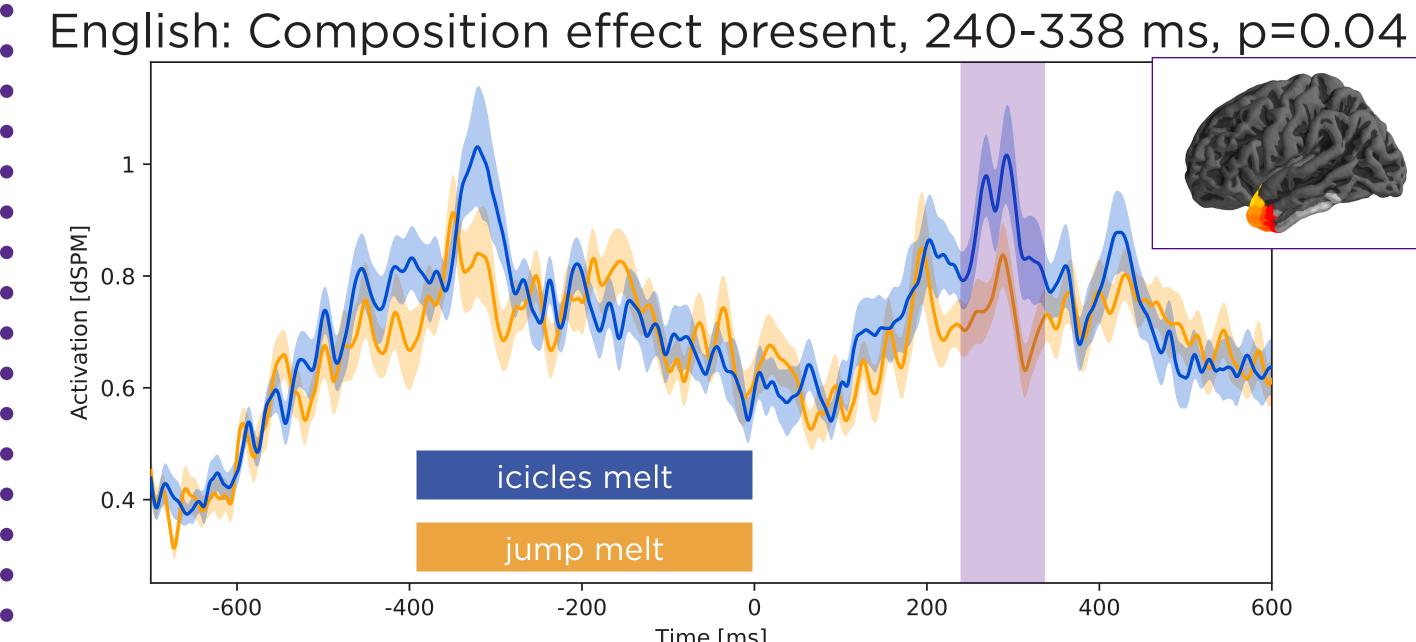
Data Collection & Analysis

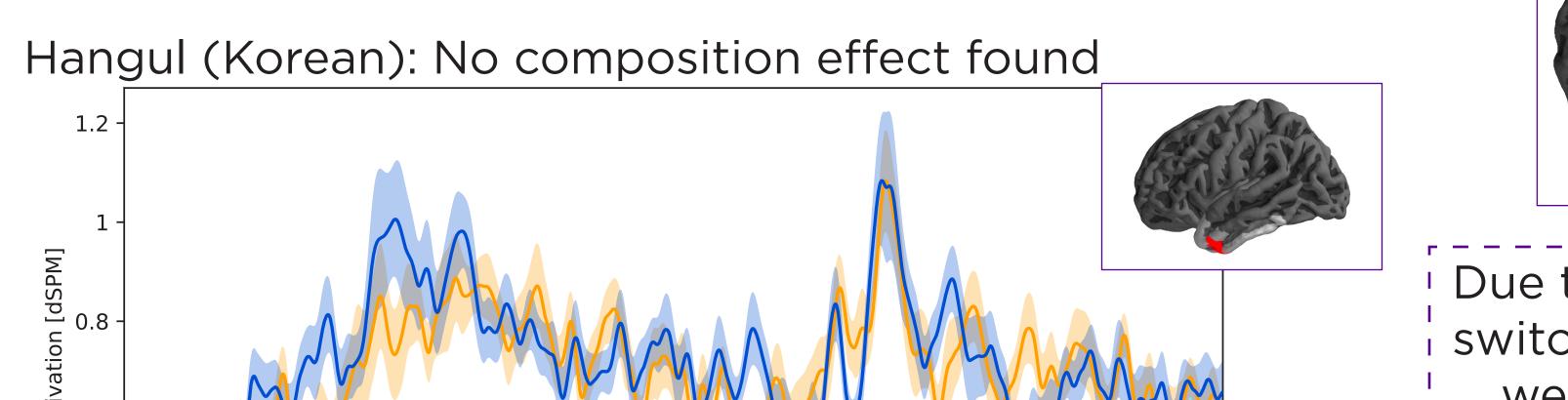
- 157-channel Magnetoencephalography system
 (Sampling rate: 1000 Hz, Low-pass filter: 200 Hz, Notch filter: 60 Hz)
- Spatiotemporal cluster permutation tests were performed in LATL (BA 38, 20, 21), ACC (BA 24, 32, 33), and dIPFC (BA 9, 10, 46)

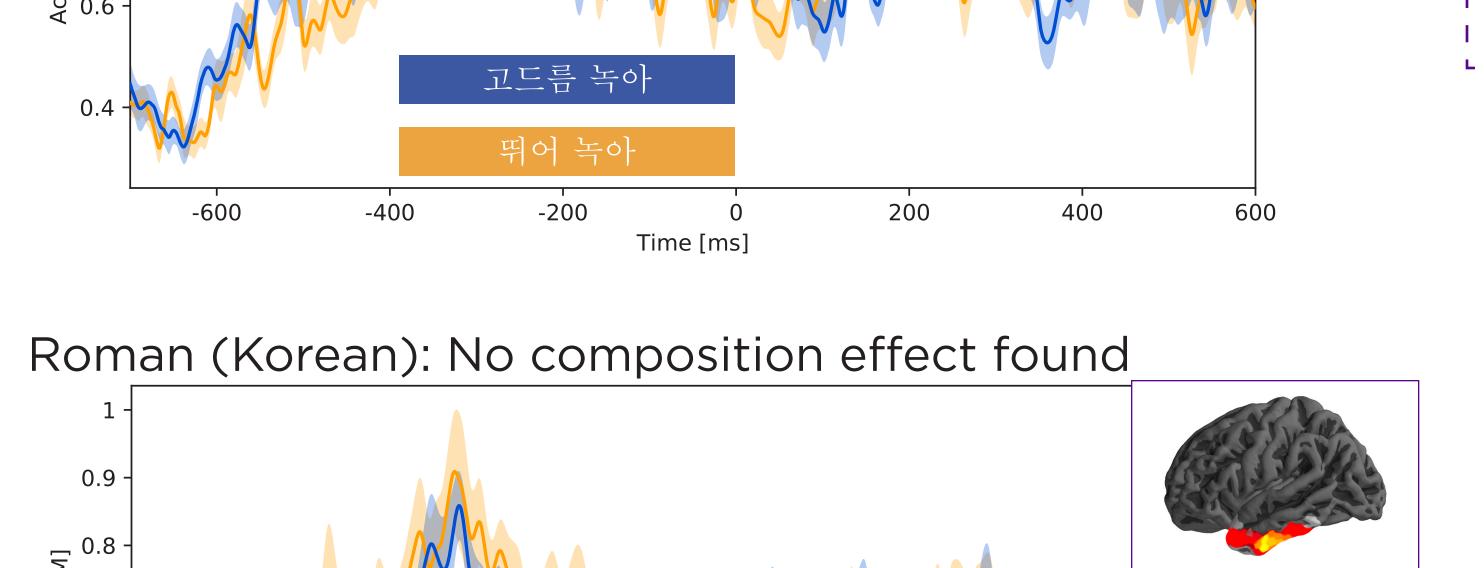
Stimuli					Experimental design by trial		
Compositional?	Languages Switch?	Orthography Switches?	Example Stimulus	Language Pair		Time lock for ROI Analyses	Time lock for Behavioral Analyses
YES	NO	NO	icicles melt	English	• 720 trials (~50 minutes)		
			godeurum noga	Roman (Korean)	Word 1	Word 2	
	YES	NO	고드름 녹아 icicles noga	Hangul (Korean) English - Roman			
			godeurum melt	Roman - English	godeurum	noga	
	YES	YES	icicles 녹아 고드름 melt	English - Hangul Hangul - English			
	NO	YES	godeurum 녹아	Roman - Hangul	+ icicles	melt	There are the second of the se
			고드름 noga	Hangul - Roman	-900 ms -300	2 ms 3	00 ms 600 ms
NO	NO	NO	jump melt	English	고드름	녹아	
			ttwieo noga 뛰어 녹아	Roman (Korean) Hangul (Korean)	-600 ms	0 ms	• COMP task:
	YES	NO	jump noga	English - Roman			Does the image match the two-
	YES	YES	ttwieo melt jump 녹아	Roman - English English - Hangul	COMP Trials: icicles	melt	word expression? • LIST task:
	123	1 L 3	뛰어 melt	Hangul - English			Does the image
	NO	YES	ttwieo 녹아	Roman - Hangul	LIST Trials: jump	melt	match one of the two words?
			뛰어 noga	Hangul - Roman			LVVO VVOIUS:

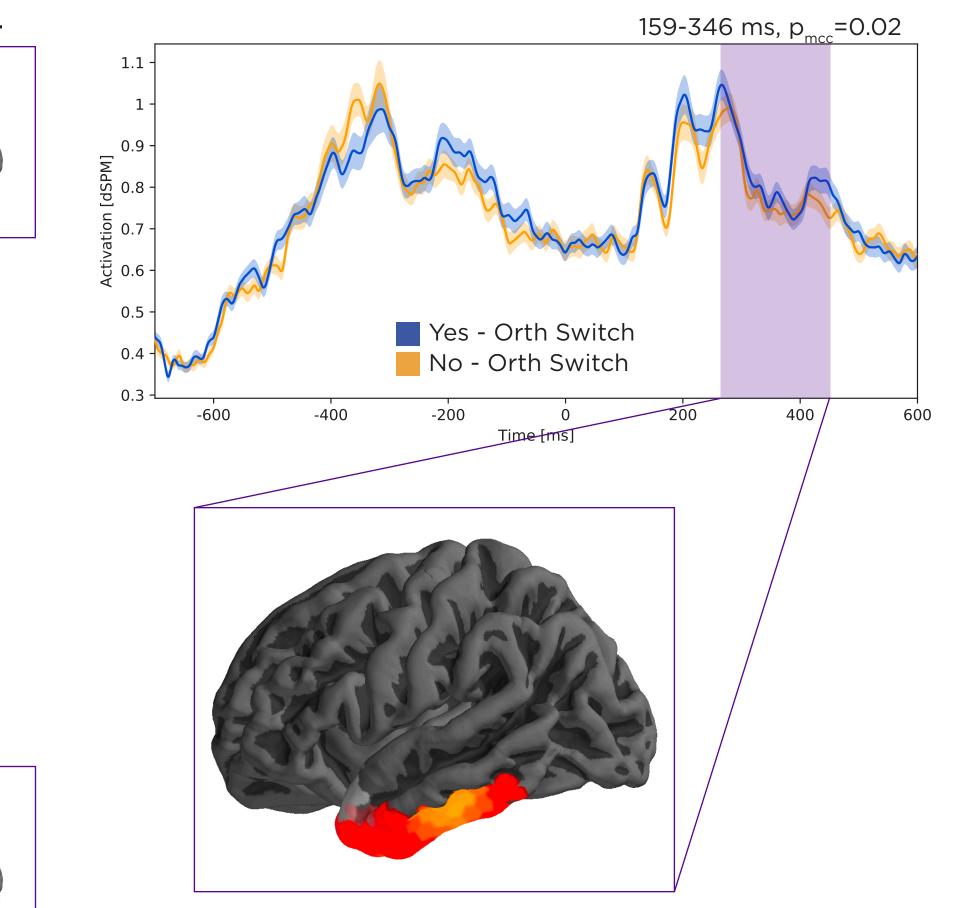
Results

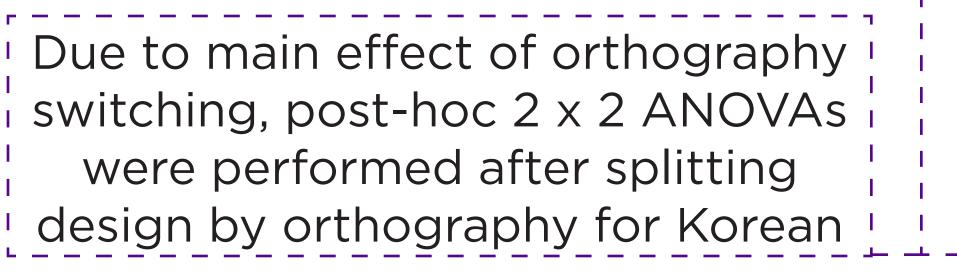
One-Way ANOVA: Composition effect in LATL for English, not Korean 2 x 2 x 2 ANOVA: Effect of switching orthographies found in LATL, interacting with language switching in dIPFC, ACC

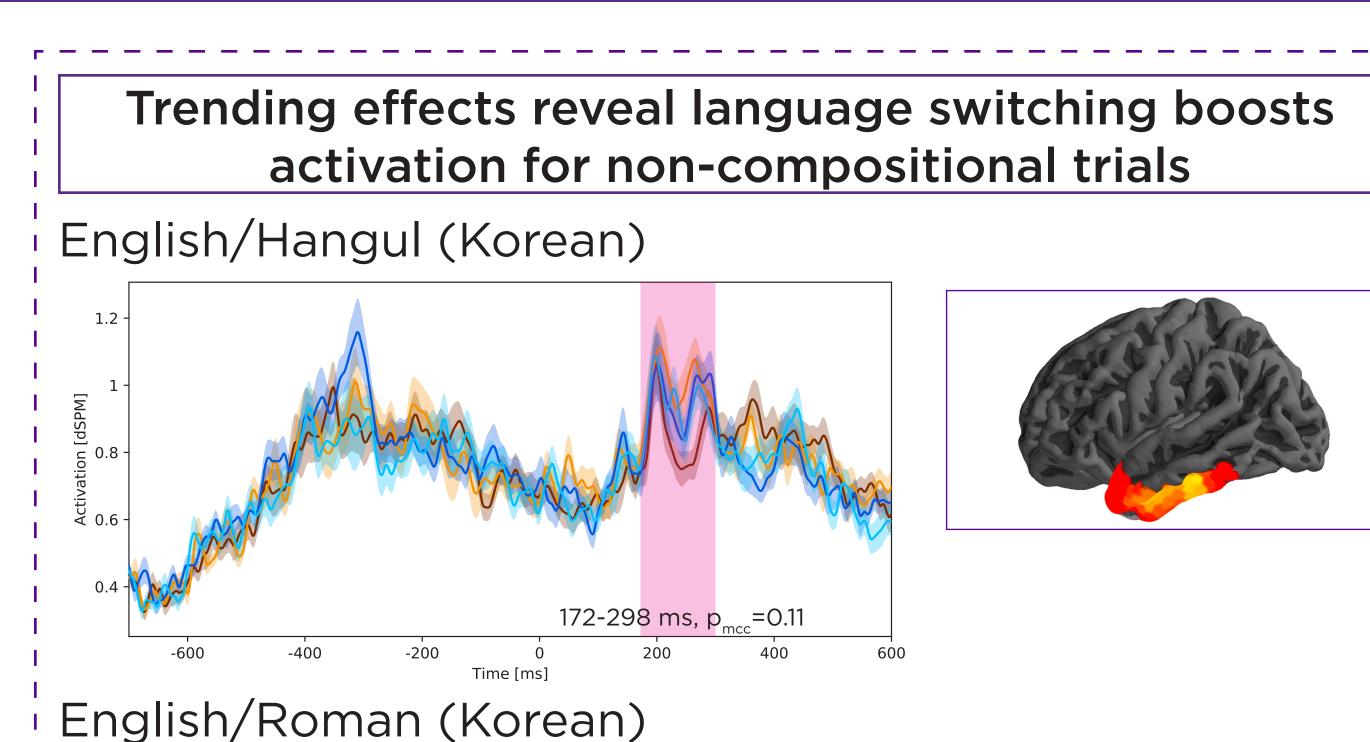


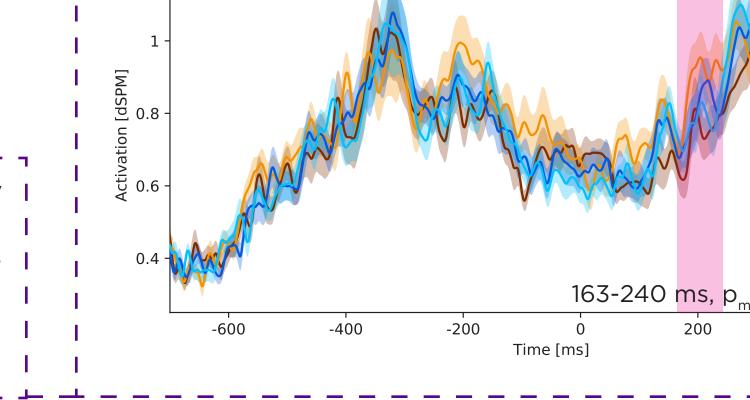


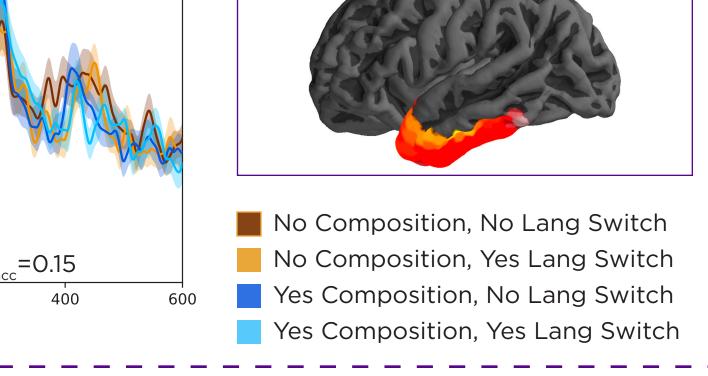


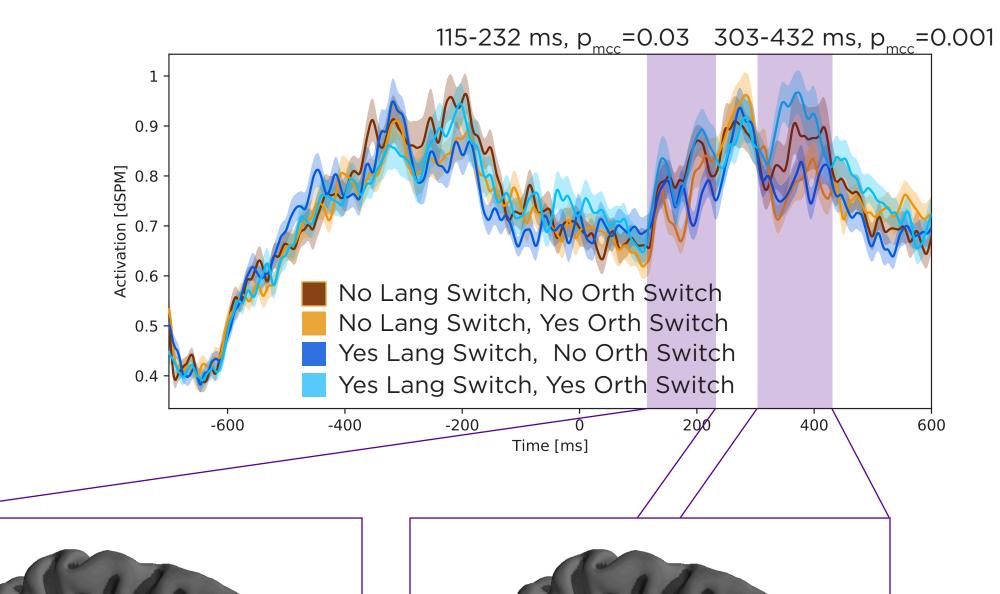


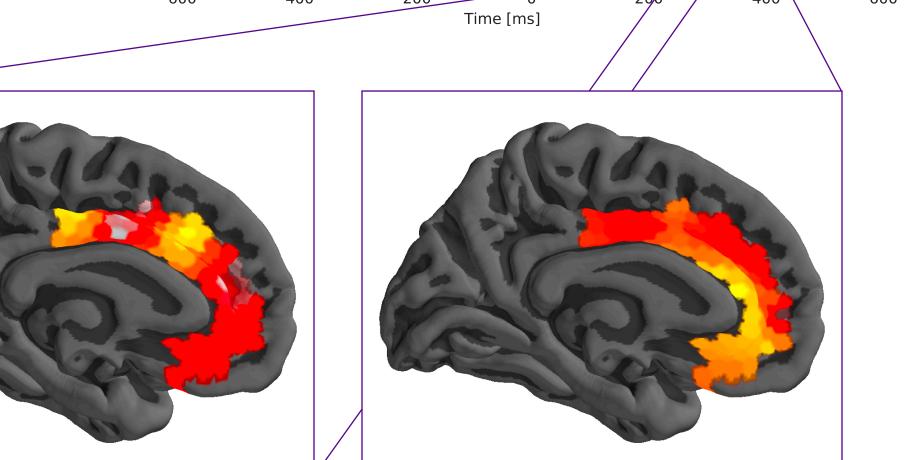


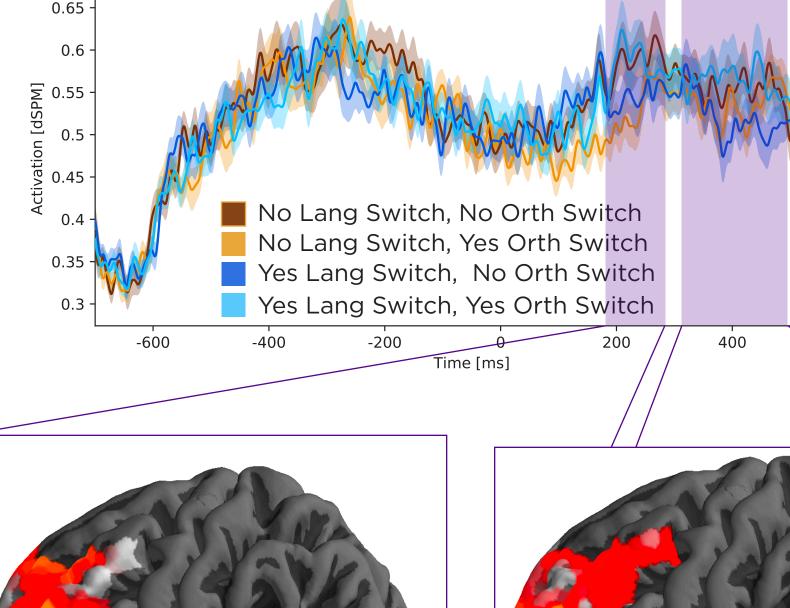


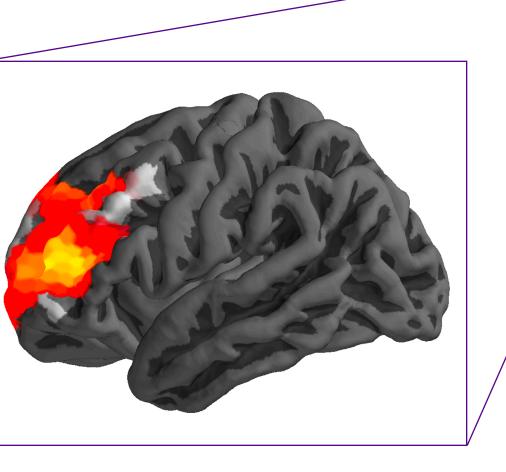


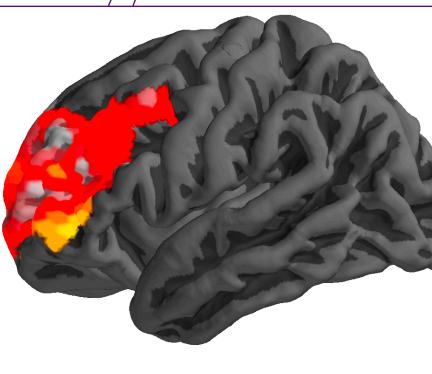












Discussion

Language switching eliminated composition effects and orthography switching affected processing in all investigated areas

- A composition effect was observed for English-only trials in the LATL, peaking at ~265 ms, but not for the Korean-only trials
- A composition effect was not observed when language-switching trials were included, even after controlling for the orthographic
 representation of Korean
- • Because Korean allows serial verb constructions, one possible explanation for the absence of a composition effect in Korean is that participants composed the two verbs in the non-compositional trials together
- Interaction effects observed in the dIPFC and ACC do not support the hypothesis that these regions are engaged for language switching
- • Surprisingly, manipulating the orthographic representation of Korean words produced robust effects in all three regions

Acknowledgments: This research was supported by NYU-Abu Dhabi Grant G1001. Many thanks to fellow NELLAB members for help with data collection and Songhee Kim for feedback on Korean stimuli, as well as Alicia Parrish and Mary Robinson for feedback on English stimuli.

Selected References: [1] Bemis, D. K., & Pylkkänen, L. (2011). Simple composition: A magnetoencephalography investigation into the comprehension of minimal linguistic phrases. Journal of Neuroscience, 31(8), 2801-2814. [2] Westerlund, M., Kastner, I., Al Kaabi, M., & Pylkkänen, L. (2015). The LATL as locus of composition: MEG evidence from English and Arabic. Brain and Language, 141, 124-134. [3] Blanco-Elorrieta, E., Kastner, I., Emmorey, K., & Pylkkänen, L. (2018). Shared neural correlates for building phrases in signed and spoken language. Scientific Reports, 8(1), 1-10. [4] Abutalebi, J., & Green, D. W. (2016). Neuroimaging of language control in bilinguals: neural adaptation and reserve. Bilingualism: Language and cognition, 19(4), 689-698. [5] Van Hell, J. G., Litcofsky, K. A., & Ting, C. Y. (2015). Intra-sentential code-switching: Cognitive and neural approaches. The Cambridge Handbook of Bilingual Processing, 459-482.