

## Background

- Complementary Learning Systems theory: (1) novel words encoded as episodic memory traces in the hippocampal system, separate from the lexicon, (2) after a period of consolidation (e.g., during sleep), these memory traces gradually become lexicalized (integrated into the lexicon).<sup>1</sup>
- Lexicalization can be measured with an EEG recorded semantic priming task.
- N400 component: indexes automatic semantic access<sup>2</sup>
- LPC component: indexes more controlled and explicit process of semantic access<sup>3-5</sup>
- Liu and Van Hell (in press) found that on Day 2 of testing, novel words learned on Day 1 demonstrated semantic priming effects in the LPC time window. On Day 8 of testing, novel words from both Day 1 and Day 2 showed semantic priming effects in the LPC time window.<sup>7</sup>

## Research Questions

- How does encoding novel words with definitions and images strengthen learning and consolidation after one night of consolidation (Test on Day 2)?
- How does encoding novel words with definitions and images strengthen learning and consolidation after a week (Test on Day 8)?

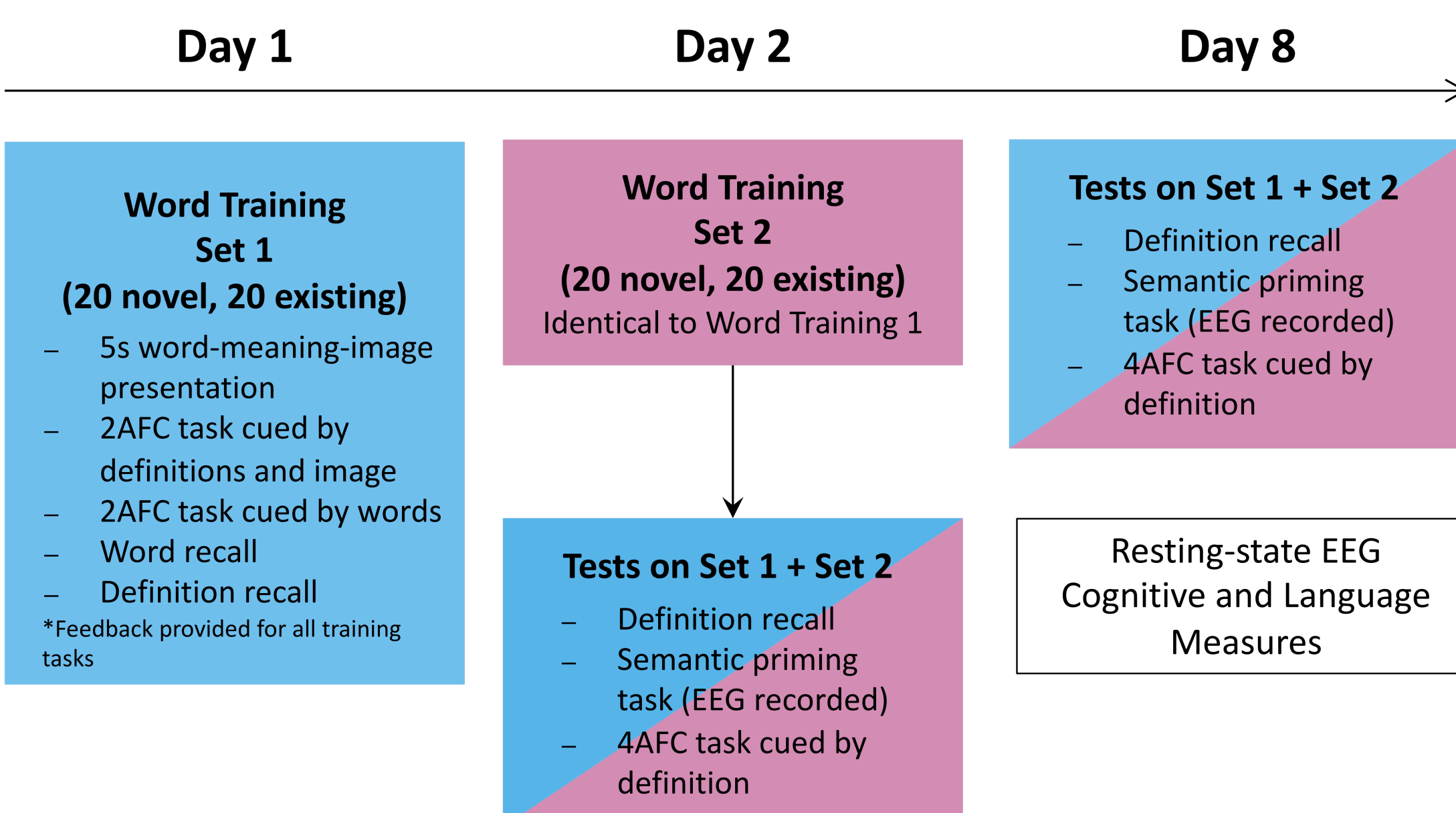
### Hypothesis

- Images DOES impact learning and consolidation
  - Test on Day 2: LPC and N400 semantic priming effect in only Day 1 novel words
  - Test on Day 8: LPC and N400 semantic priming effect in both Day 1 and Day 2 novel words

### Alternative hypothesis

- Images does NOT impact learning and consolidation
  - Replicate results in Liu and Van Hell (in press)<sup>7</sup>.

## Study Design



## Acknowledgements

NSF GRFP Grant No. DGE1255832 to Daisy Lei.  
NSF BCS-1349110 and REU supplement to Janet van Hell.  
\*The authors would like to thank Amber Liu for help with the novel word images.

Contact: dul261@psu.edu (Daisy Lei)

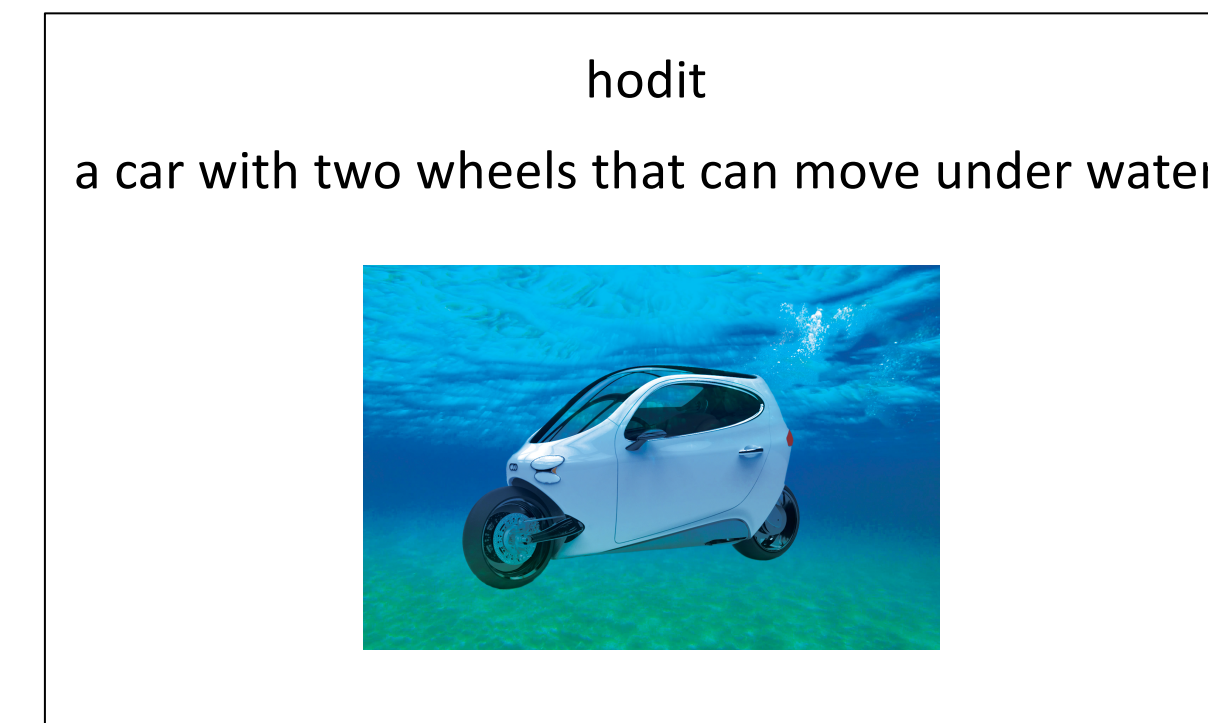
## Methods

### Participants

- 31 right-handed monolingual native English speakers (*M* age = 19, range = 18 – 21)

### Materials and stimuli

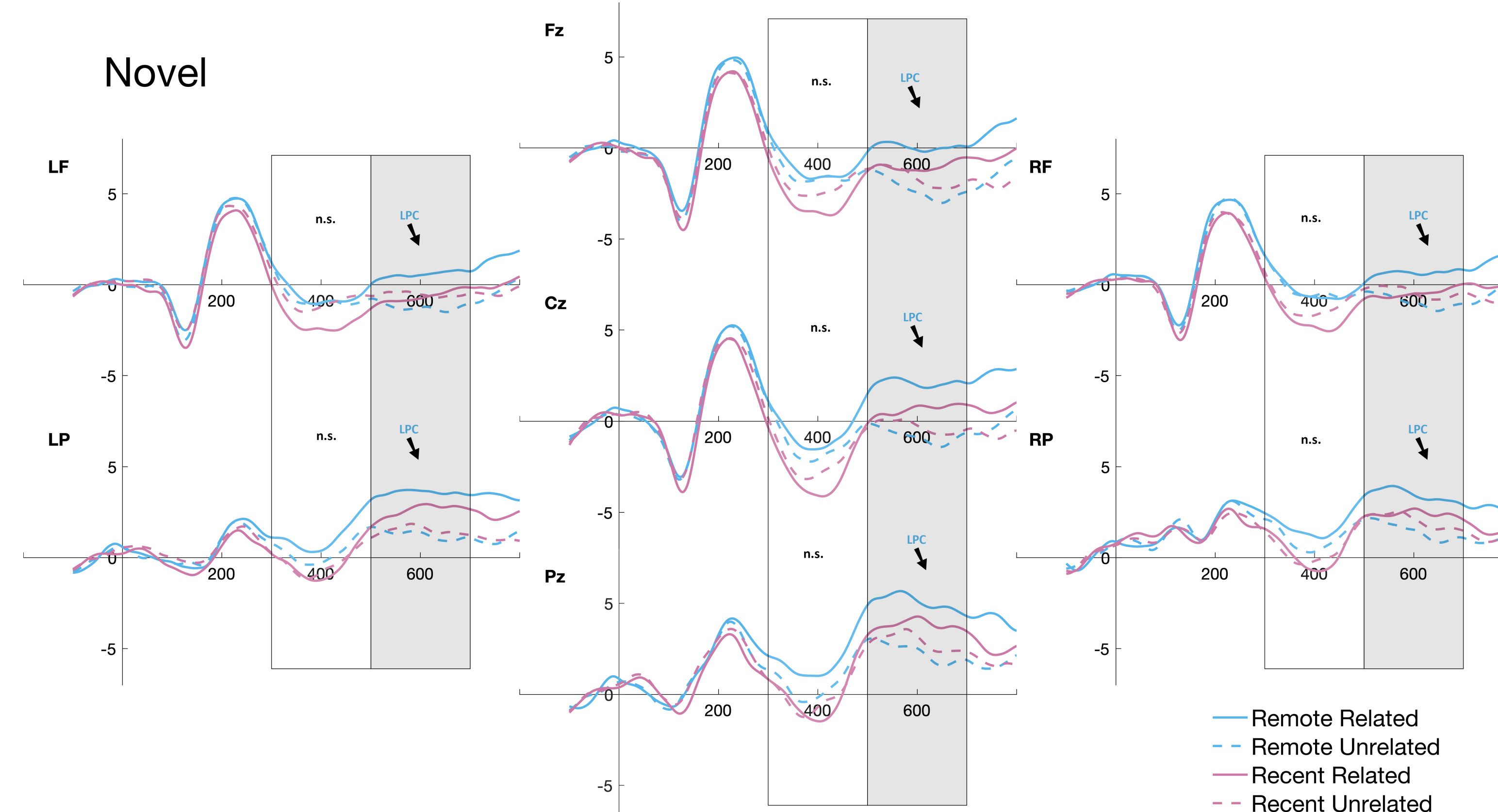
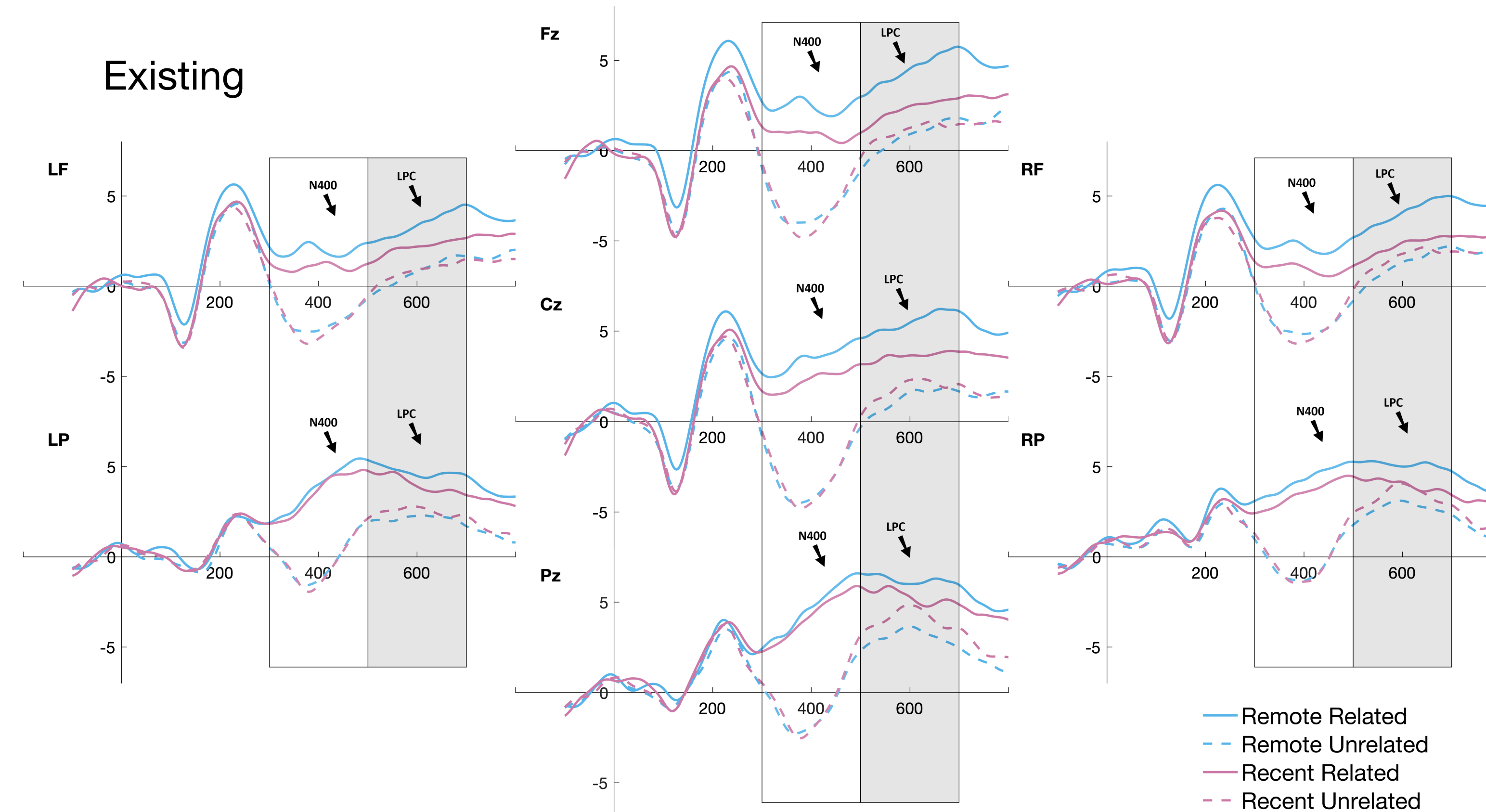
- 2 sets of 20 novel words and 20 existing words each (80 total) and their definitions, from<sup>7</sup>
- Images for all words\*
- Novel words:
  - 40 non-derivational non-words (e.g., *hodit*), from<sup>8</sup>
  - Phonotactically legal in English with no orthographic neighbors



### ANOVA Analyses

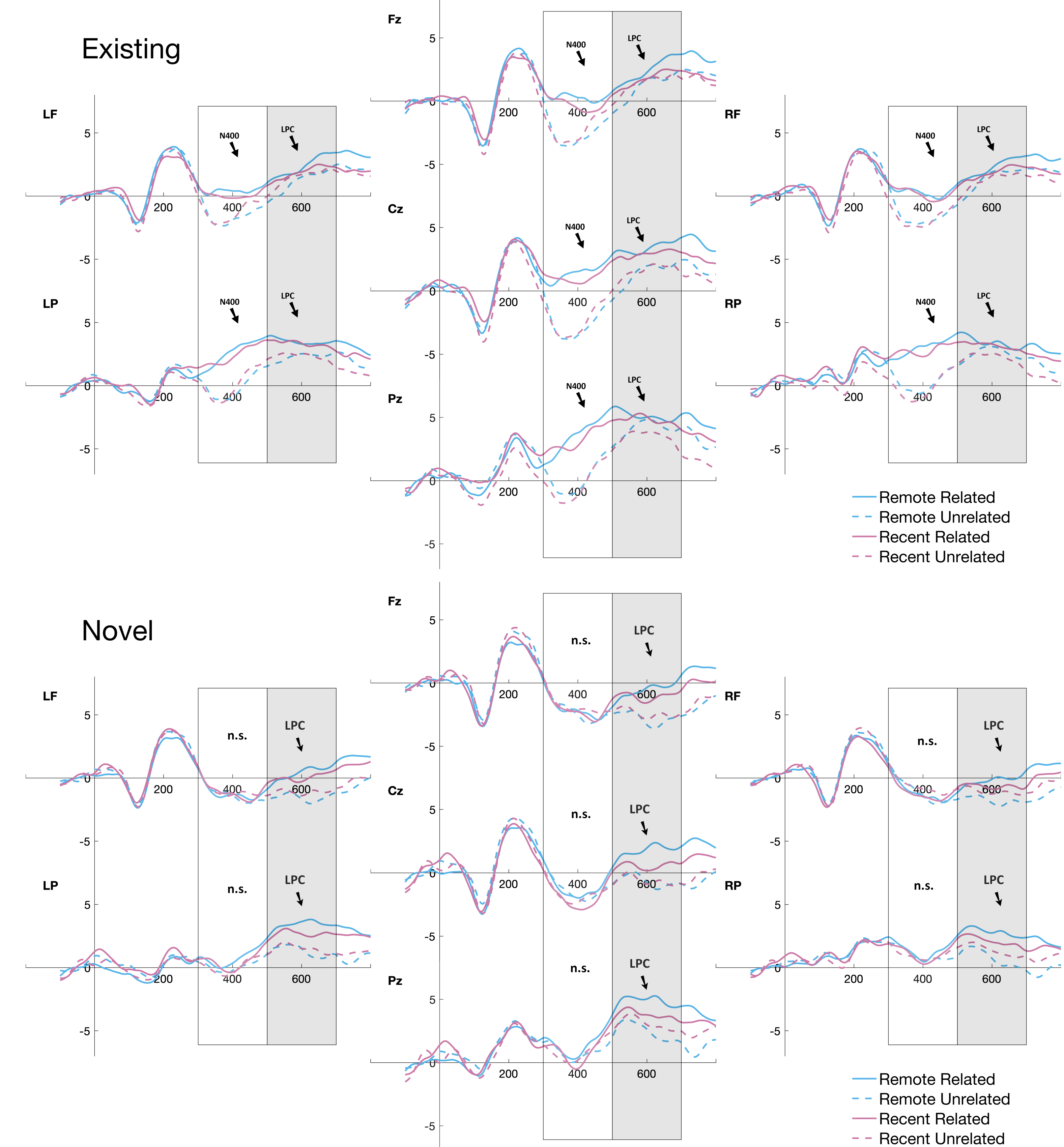
- Midline: Condition (Remote, Recent) x Relatedness (Related, Unrelated) x Midline (Fz, Cz, Pz)
- Laterality: Condition (Remote, Recent) x Relatedness (Related, Unrelated) x Anteriority (Anterior, Posterior) x Laterality (Left, Right)

## ERP Results: Test on Day 2 (N = 31)



- Day 1 novel words: LPC semantic priming effect across the 3 midline channels and all lateral ROIs.
- Day 2 novel words: No semantic priming effect.

## ERP Results: Test on Day 8 (N = 23)



- Day 1 novel words: LPC semantic priming effect across the midline and all ROIs.
- Day 2 novel words: LPC semantic priming effect across the midline and all ROIs.
- No N400 semantic priming effect were found.

## Conclusion

- Novel words paired with definition *and* images demonstrate an LPC semantic priming after a night of offline consolidation for novel words learned on Day 1.
- After a week of offline consolidation, novel words learned on Day 2 also demonstrate an LPC semantic priming effect (larger in the left regions).

**Images does not strengthen the encoding and consolidation of novel words more than with verbal definition.**

## References

- Davis, M. H., & Gaskell, M. G. (2009). A complementary systems account of word learning: neural and behavioural evidence. *Philos. Trans. Royal Soc. B*, 364(1536), 3773-3800.
- Kutas, M., & Federmeier, K. D. (2011). Thirty years and counting: finding meaning in the N400 component of the event-related brain potential (ERP). *Annu. Rev. Clin. Psychol.*, 62, 621-647.
- Hoshino, N., & Thierry, G. (2012). Do Spanish-English bilinguals have their fingers in two pies—or is it their toes? An electrophysiological investigation of semantic access in bilinguals. *Front. Psychol.*, 3, 9.
- Juottonen, K., Revonsuo, A., & Lang, H. (1996). Dissimilar age influences on two ERP waveforms (LPC and N400) reflecting semantic context effect. *Brain Res.*, 4(2), 99-107.
- Rohaut, B., Faugeras, F., Chausson, N., King, J. R., El Karoui, I., Cohen, L., & Naccache, L. (2015). Probing ERP correlates of verbal semantic processing in patients with impaired consciousness. *Neuropsychologia*, 66, 279-292.
- Bakker, I., Takashima, A., van Hell, J. G., Jansen, G., & McQueen, J. M. (2015). Tracking lexical consolidation with ERPs: Lexical and semantic-priming effects on N400 and LPC responses to newly-learned words. *Neuropsychologia*, 79, 33-41.
- Liu, Y., & Van Hell, J. (in press). Learning novel word meanings: An ERP study on lexical consolidation in monolingual, inexperienced foreign language learners. *Lang. Learn.*
- Deacon, D., Dynowska, A., Ritter, W., & Grose-Fifer, J. (2004). Repetition and semantic priming of nonwords: Implications for theories of N400 and word recognition. *Psychophysiology*, 41(1), 60-74.