

## Introduction

The present study used Event-related potentials (ERPs) to investigate whether Heritage speakers of an endangered language (Hñáñho) activate phonological representations of both of their languages while learning written words of their non-spoken heritage language.

Previous ERPs studies have shown that during the first stages of acquisition of an unknown language, written words with a high Orthographic Neighborhood Density (OND) increases the amplitude of the N400 during a language decision task after 3 sessions of training (Meade, et al. 2018). Moreover, it has been observed that not only orthographic but also phonological neighborhood density (PND) affect the amplitude of the N400 during visual word recognition in first language (Carrasco-Ortiz, et al. 2017)

However, less is known about the extent to which Phonological Neighborhood Density (PND) across Hñáñho and Spanish can influence vocabulary acquisition of Hñáñho written words in heritage speakers. Furthermore, the use of phonological knowledge of a non-spoken heritage language on written word learning provides an interesting approach to explain the activation of phonological representations during language learning.

We hypothesized heritage speakers would benefit from early exposition to the oral language form when learning written words as compared to Spanish monolinguals with no previous exposition to the language. In general, Hñáñho written words with higher PND with Spanish would be acquired with more ease than words with lower PND. This PND effect on the amplitude of the N400 should be present for Hñáñho Heritage Speakers in contrast to Spanish monolinguals.

## Methods

**Participants:** 14 Spanish speakers (ages 18–35) and 14 Hñáñho Heritage speakers (ages 18-35)

**Stimuli:** 60 Hñáñho noun words (2-6 letters) were divided into two groups according to their Phonological Neighborhood Density with Spanish (PND). (standard deviations in parenthesis)

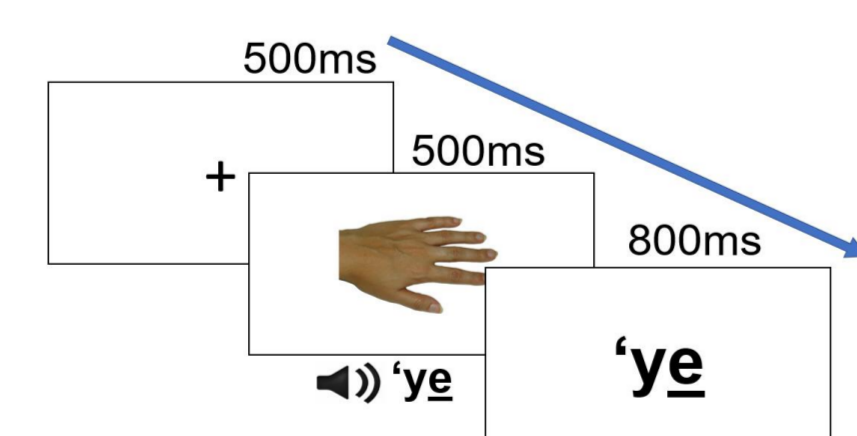
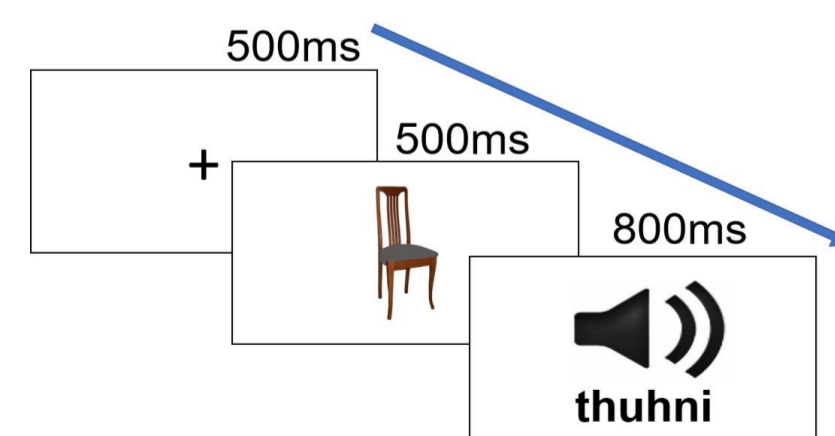
PND	OLD20	PLD20	Letters	Frequency
High	2.28 (±0.53)	2.04 (±0.54)	3.53 (±1.04)	25.92 (±33.93)
Low	2.17 (±0.54)	2.42 (±0.61)	3.77 (±1.17)	28.11 (±28.08)

**Procedure:**

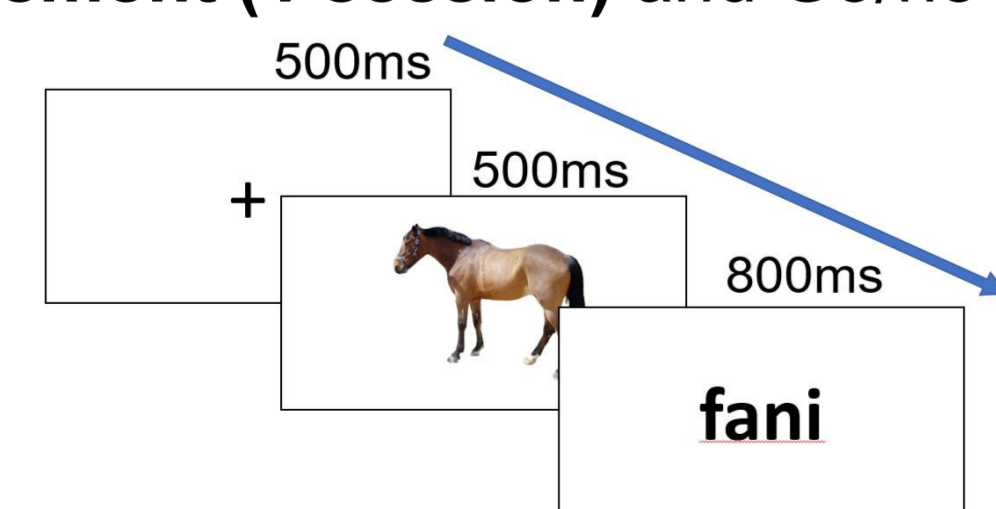
**Training (2 sessions):** Passive + Forced choice blocks

Task 1. Association: image-audio

Task 2. Association: image-audio-written word



Task 3. ERP assessment (1 session) and Go/no-go: image-written word

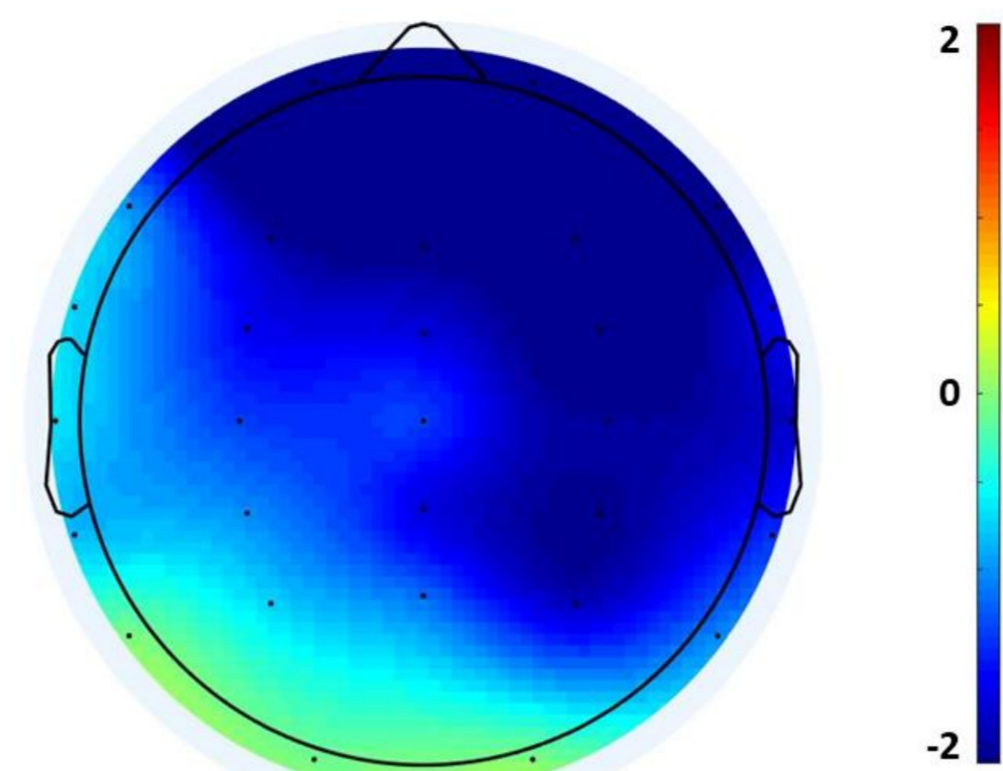


## References

Carrasco-Ortiz, et al. (2012) *Psychophysiology*, 49(4), 531-43  
 Carrasco-Ortiz, et al. (2017) *Journal of Neurolinguistics*, 41, 1-10.  
 Comesaña, et al. (2012) *Neuroscience Letters*, 559(1), 75-79  
 Dijkstra & van Heuven (2002) *Language and Cognition*, 5, 175-197  
 Dimitropoulou et al. (2011) *Journal of Cognitive Psychology*, 23 185-203  
 Haigh & Jared (2007) *Journal of Experimental Psychology: Learning, Memory and Cognition*, 33, 623-644  
 Meade, et al. (2018) *Journal of Cognitive Neuroscience*, 30(1), 70-85.

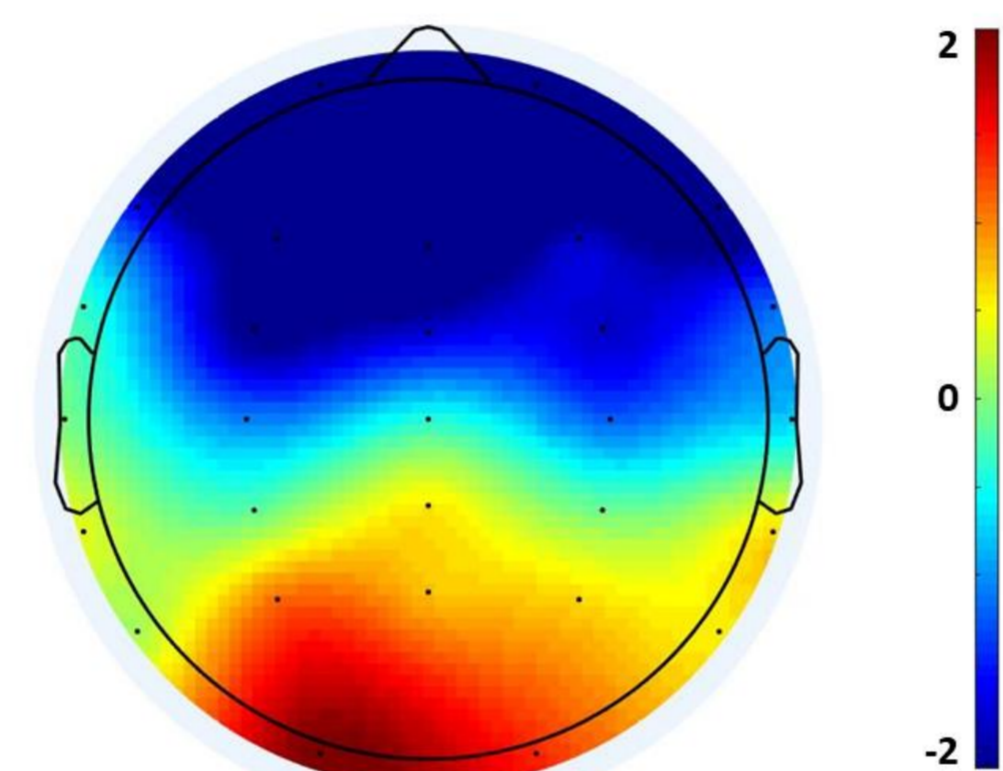
## Results

### Hñáñho Heritage Speakers



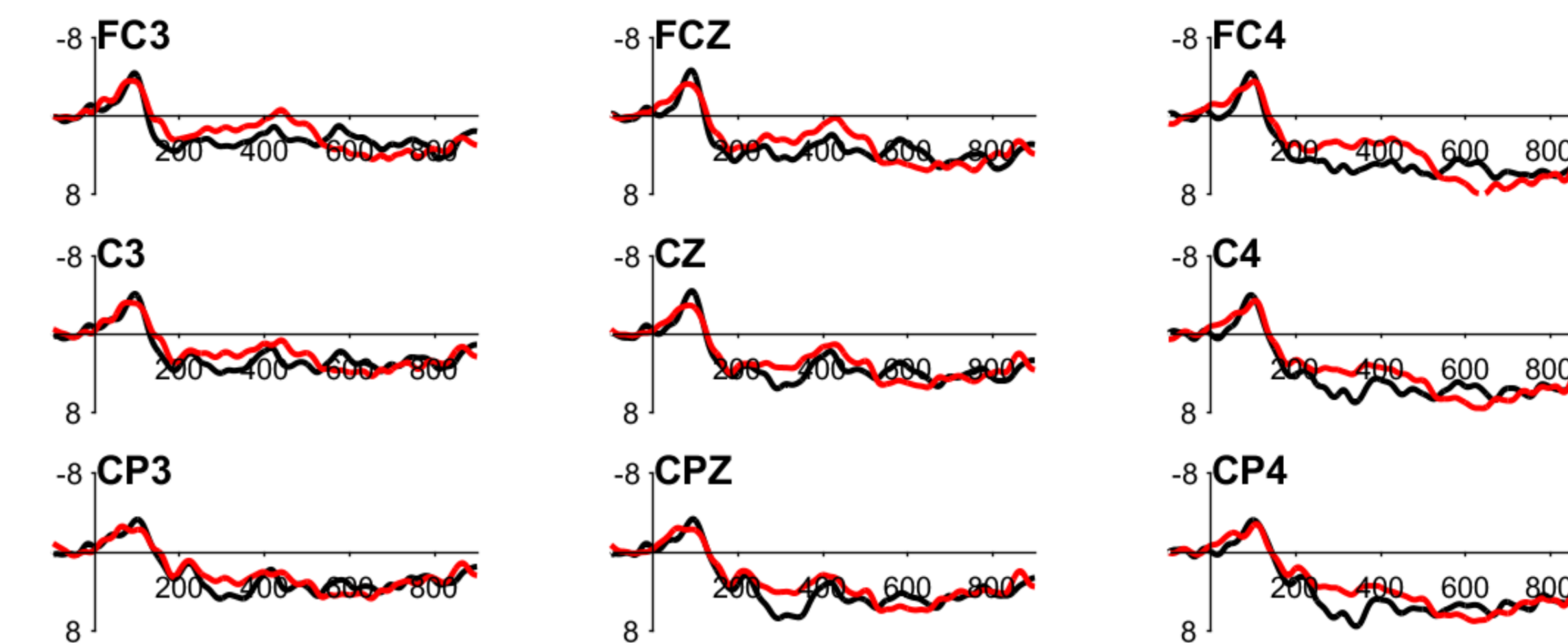
High PND – Low PND  
300 – 450 ms

### Spanish Monolinguals

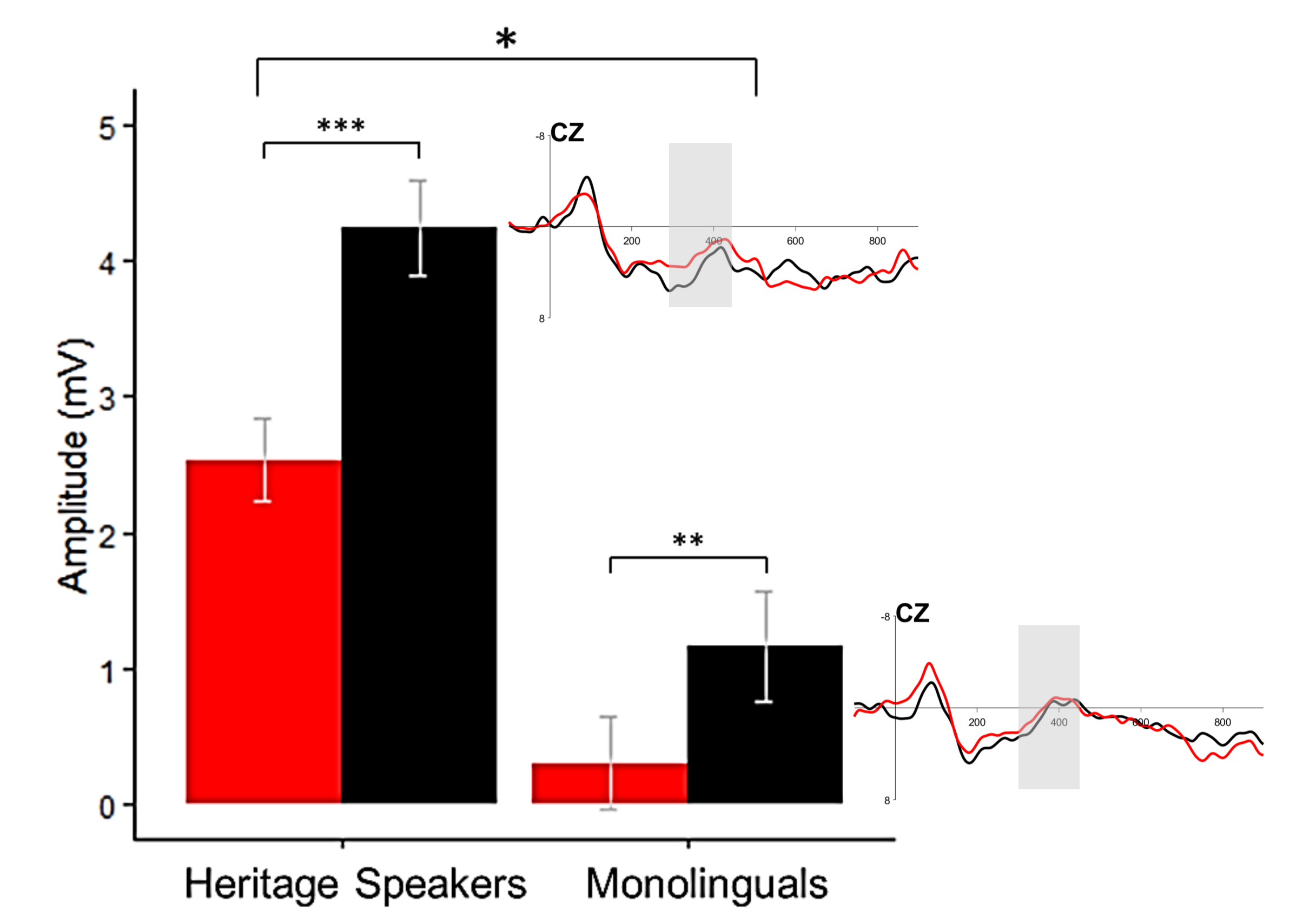
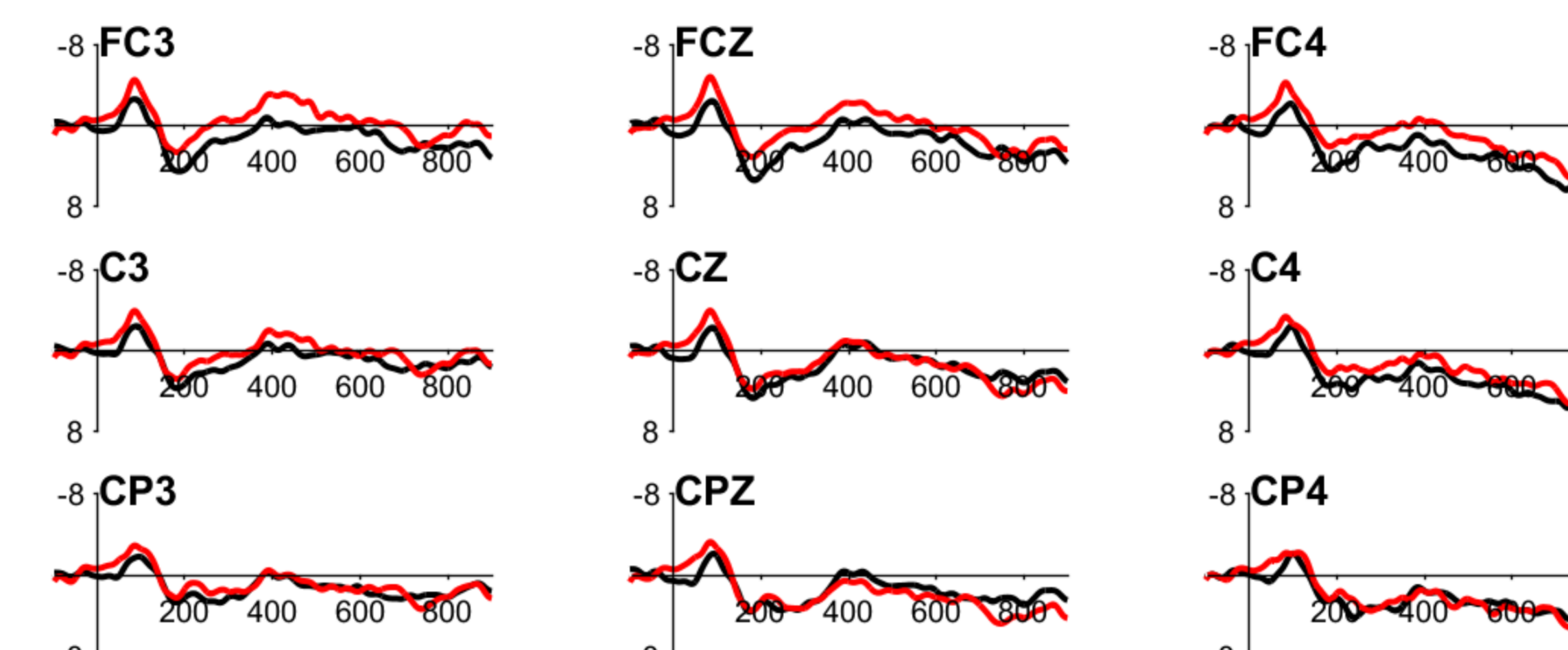


High PND – Low PND  
300 – 450 ms

### ERPs Hñáñho Heritage Speakers

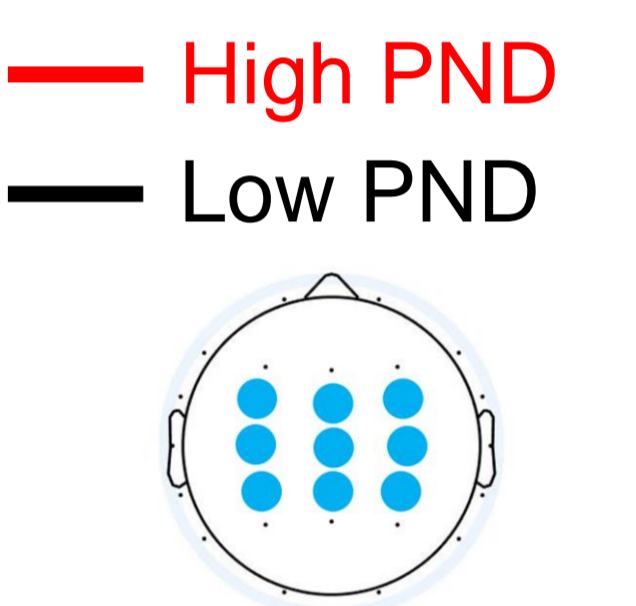


### ERPs Spanish Monolinguals

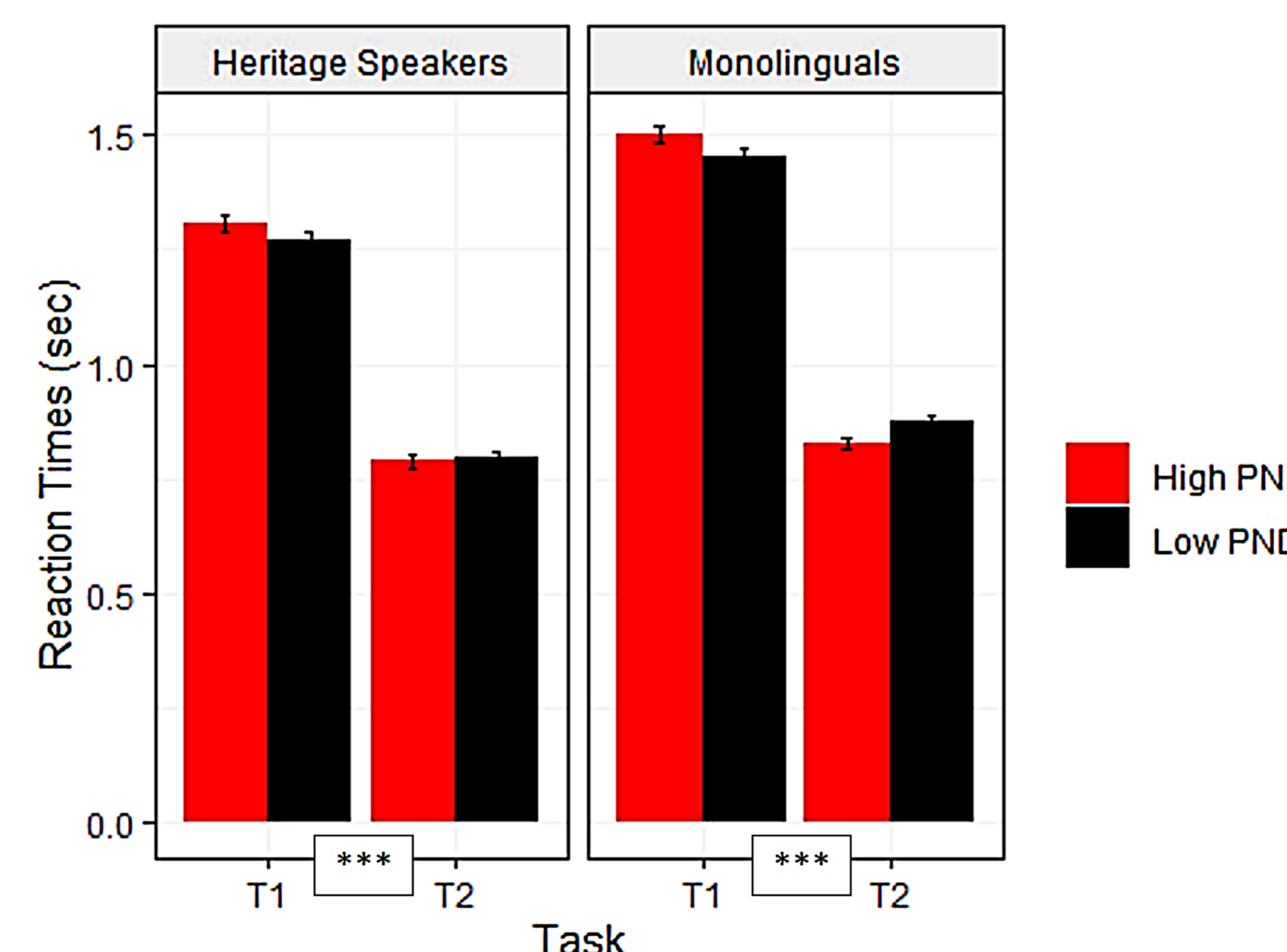


An interaction between Group and PND in the time window of 300–450 ms showed that:

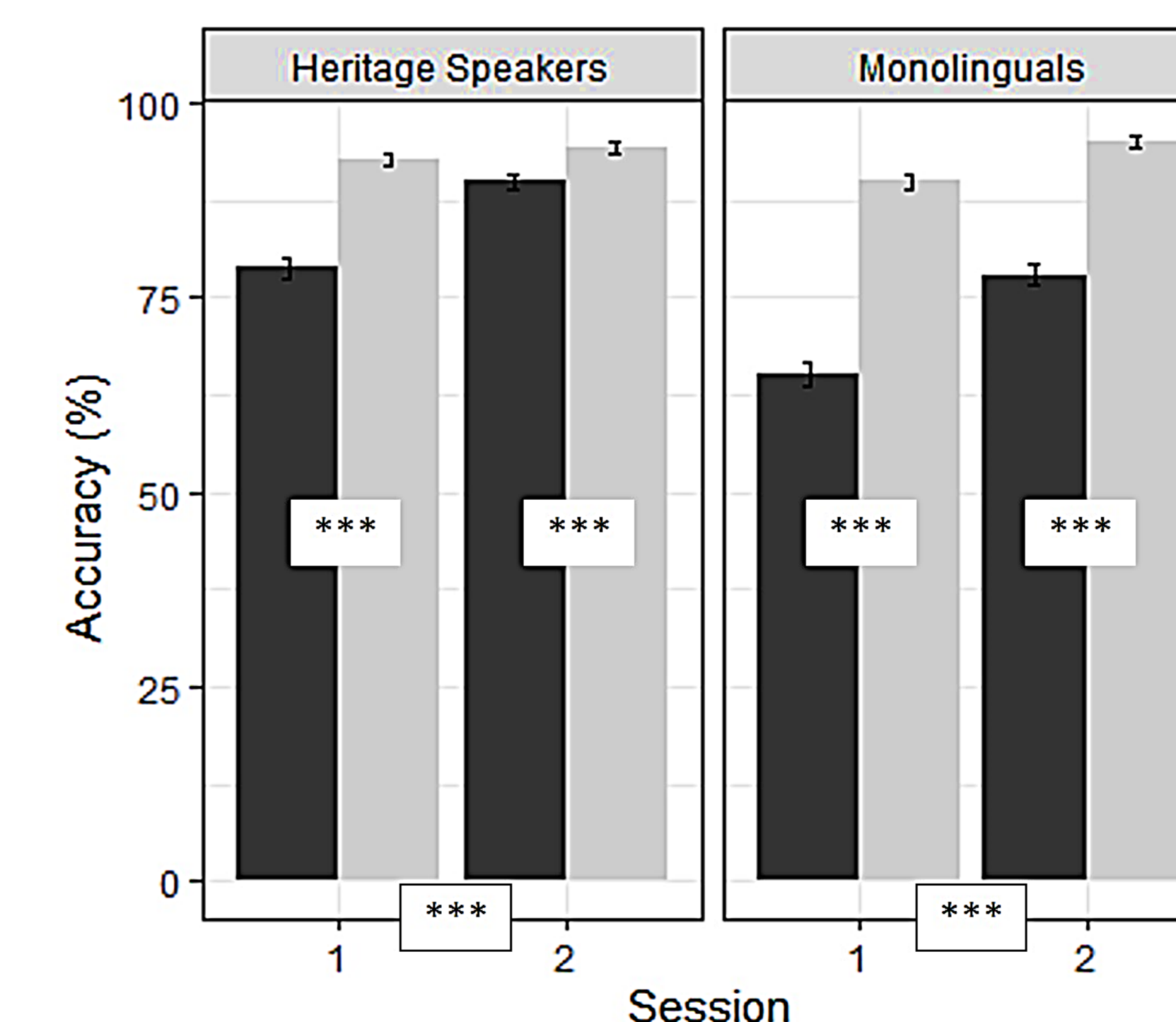
- Heritage speakers elicited smaller N400 amplitudes in response to words with high PND compared with low PND
- Monolinguals show a significant smaller PND effect compared to the PND effect observed in heritage speakers



### Behavioral Training (Tasks 1 and 2)

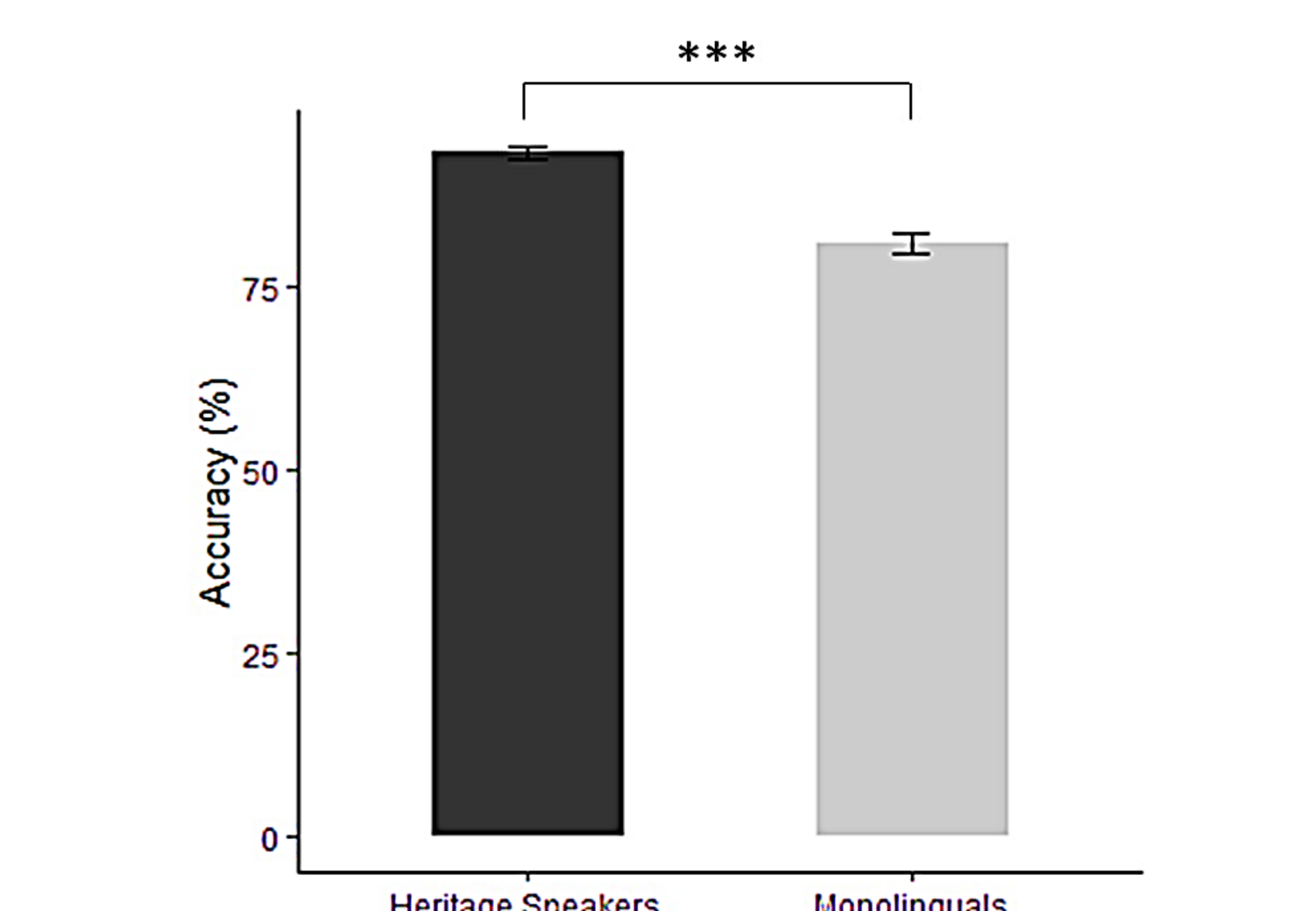


An effect of task revealed that both participant groups were faster responding to image-audio-written word associations than to image-audio associations



An interaction between Session and Task showed that both participant groups were more accurate as they progressed from the first to the second session. However, in each session they were better at identifying image-audio-written word associations than image-audio associations

### Behavioral Assessment (Task 3)



Heritage speakers identified image-written word form associations more accurately than Monolinguals

## Conclusions

Words with a large number of phonological neighbors elicited larger N400 amplitude than words with a small number of phonological neighbors across languages. This PND effect was stronger for Heritage speakers compared to the PND effect observed for Monolinguals.

- These findings suggest parallel activation of both Hñáñho and Spanish phonological representations as Heritage speakers read silently in their non-spoken language. This is in line with previous ERP studies showing cross-language activation at the phonological level of representation (Carrasco-Ortiz et al. 2012; Comesaña, et al. 2012).
- Interestingly, high levels of speaking competence do not seem to be necessary for Heritage speakers to develop phonological representations of words in their heritage language. Early and continuous exposure to auditory word forms would be enough for heritage learners to build interconnected phonological representations across their languages, which is in line with the BIA+ model proposed by Dijkstra and van Heuven (2002).
- Finally, the present findings add to previous bilingual studies showing a phonological mediation in written word recognition (Dimitropoulou et al. 2011; Haigh & Jared, 2007).