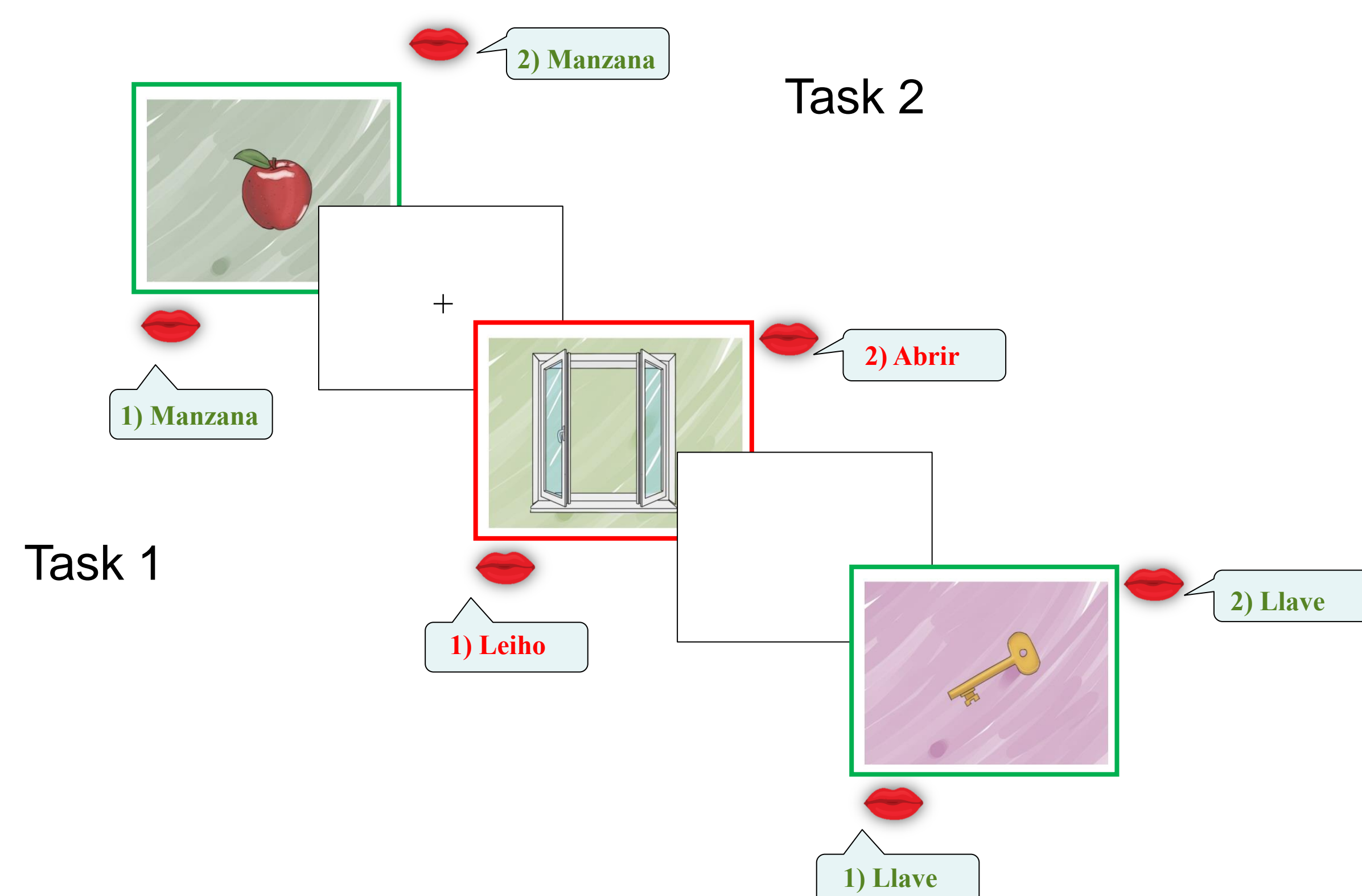


## INTRODUCTION

- How do bilinguals control language production?
- Previous M/EEG studies [1-3] trying to answer this question show language switching effects:
  - Between 200-300ms in the left temporal lobe
  - Between 300-450ms in the dorsolateral prefrontal and anterior cingulate cortices
- Controversial literature on underlying control mechanisms due to differences in participant's profiles, experimental procedures and other factors.
- One question that remains unanswered is whether different linguistic control mechanisms subserve language and semantic category switching and if they follow the same time course.
- Another question of this study is whether production in L1 and production in L2 involve the same mechanisms in balanced bilinguals.
- Here, we try to shed light on these aspects by investigating the mechanisms underlying Spanish vs. Basque and Noun vs. Verb switching, respectively.

## METHODS

- MEG 306-channel ELEKTA-Neuromag system & individual T1s
- 20 early bilinguals (4 males, mean age 24.75; SD = 3.82)
- Switch production task:
  1. Between-language switching (Spanish - Basque)
  2. Within-language switching (Object - Verb) in Spanish and Basque

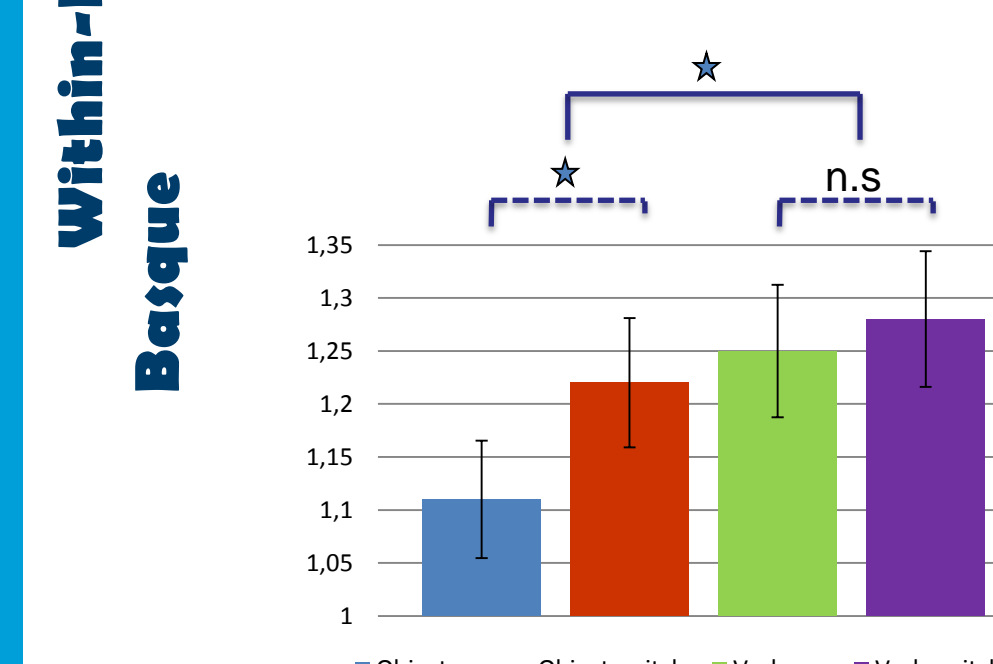
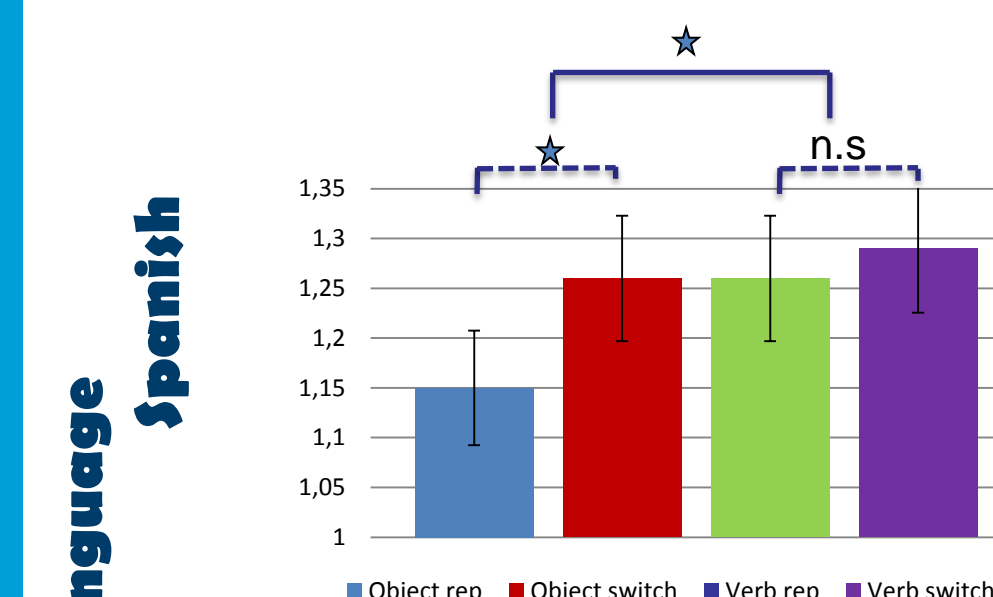
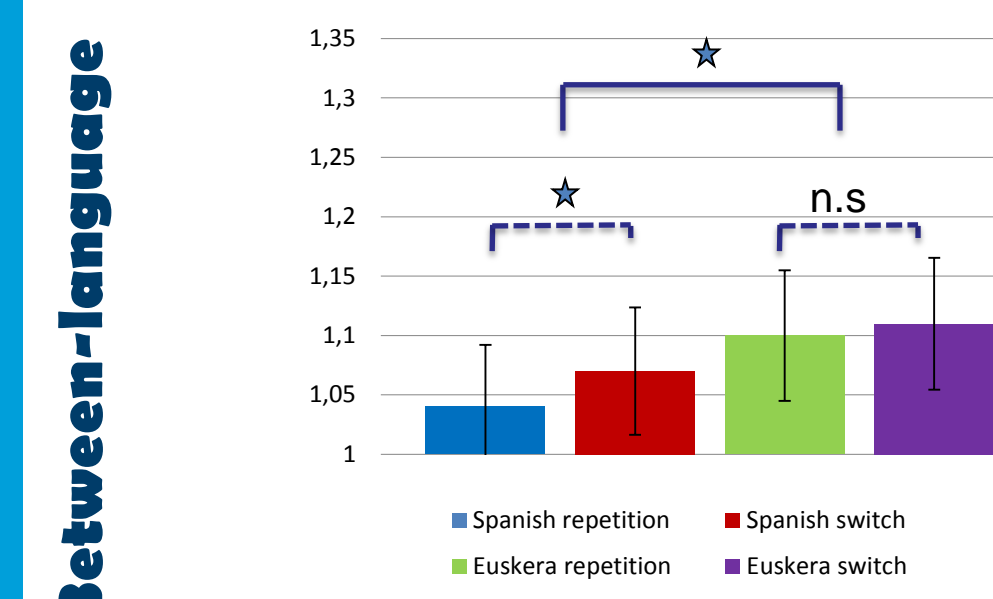


### Data analysis:

- Data were pre-processed and analyzed using Brainstorm [4].
- Behavioral data analysis. Response time (RT) values were analyzed using analysis of variance (ANOVA) with Language (L1 vs. L2) and Trial Type (Switch vs. Non-switch) as within subjects factors.
- ERF analysis. Cluster-based permutation test (0 – 600 ms).
- Source reconstruction (dSPM) of significant sensor effects.

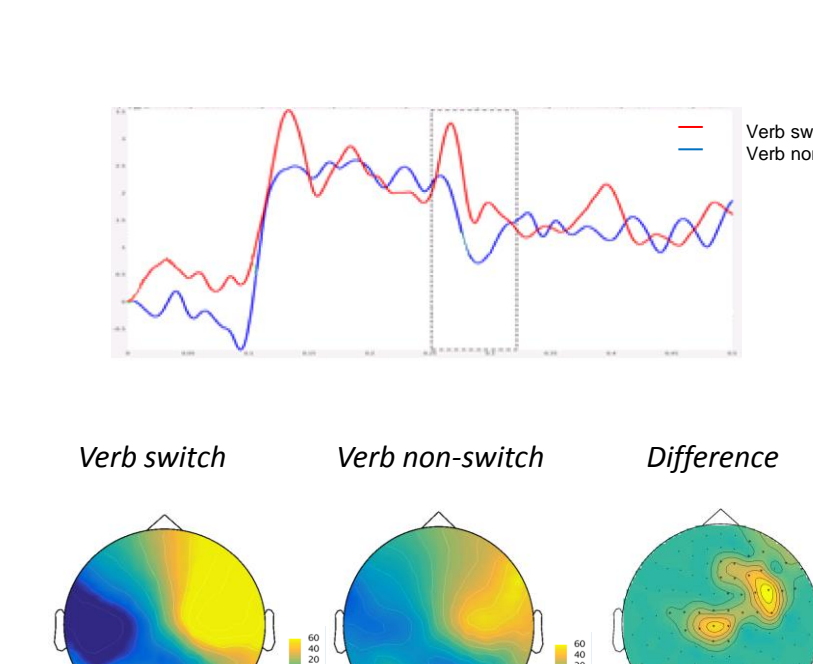
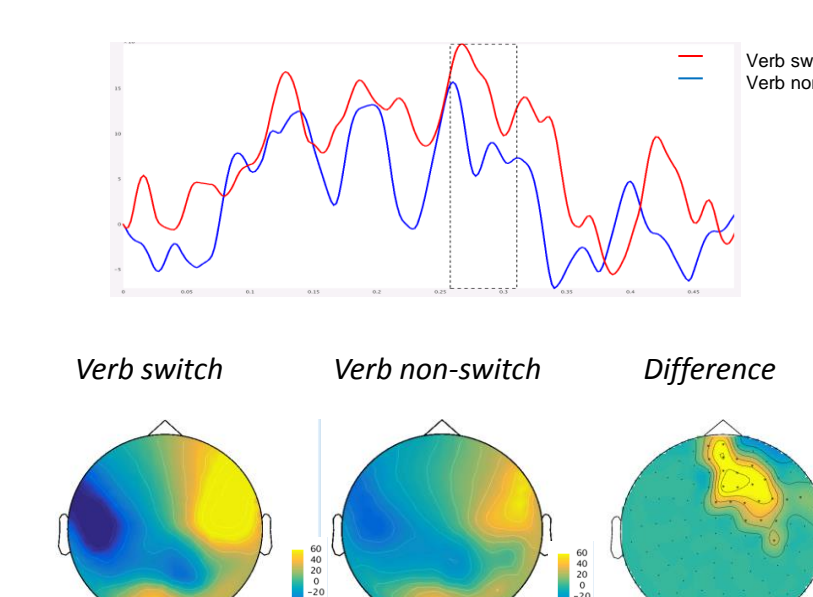
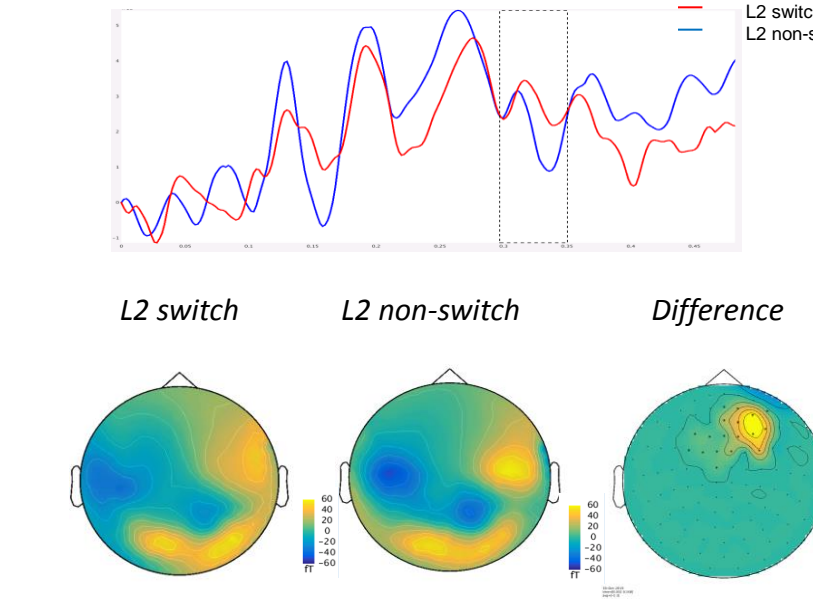
## RESULTS

### Results 1: Behavioral



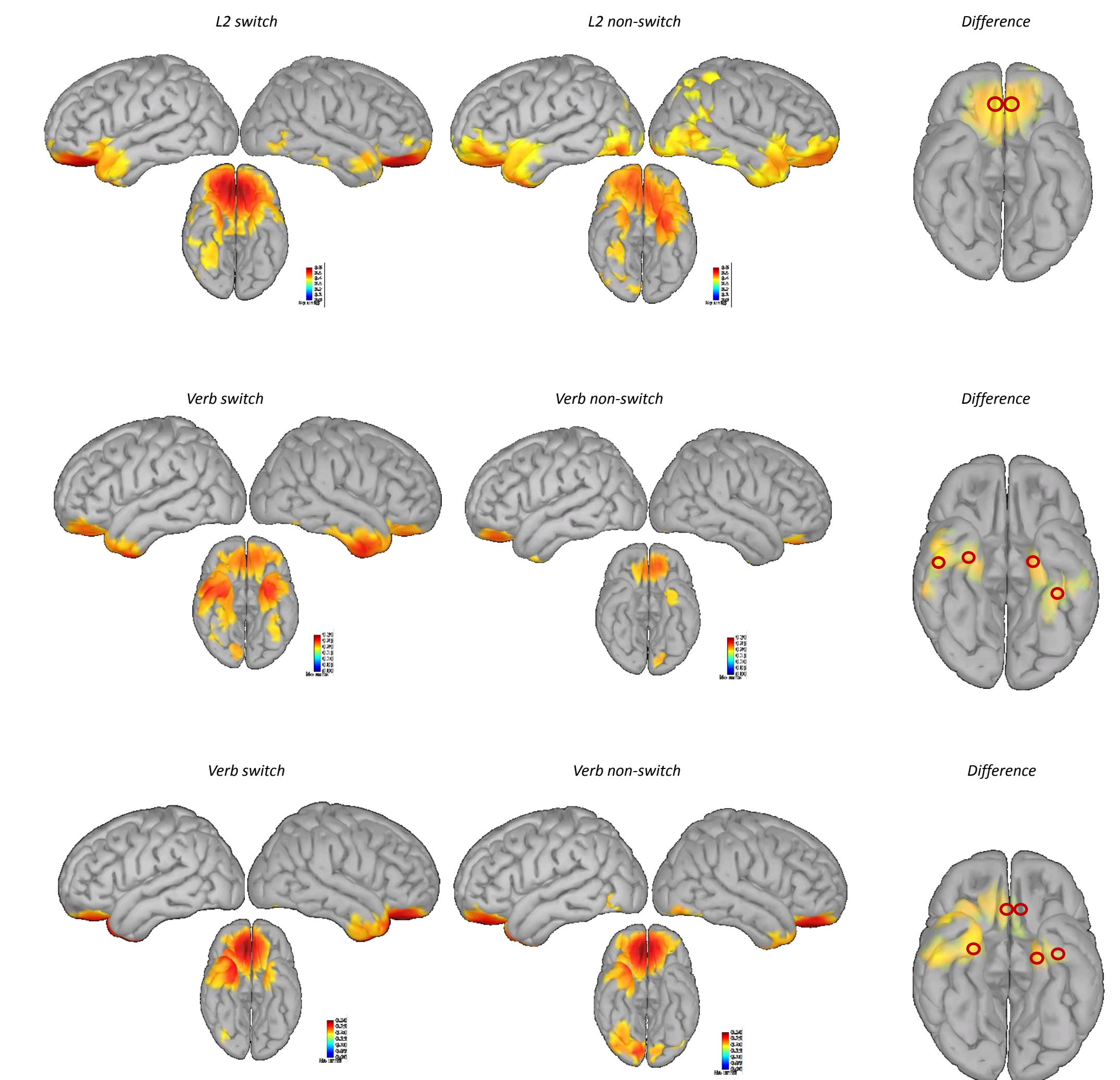
- Significant main effect of:
  - Language (p=0.02) in bilingual context.
  - Category (p=0.006) for spanish category switching
  - Condition (p=0.02) and Category (p=0.001) in Basque
- Planned comparisons showed:
  - Switch effect for L1 (p=0.04), but not L2 (p=0.91)
  - Objects (p=0.03), but not verbs (p=0.68) for Spanish
  - Objects (p=0.005), but not verbs (p=0.47) for Basque

### Results 2: ERFs



- No significant differences between switch vs repetition in L1 and in objects in both languages
- 250-350ms: Power increases for the switching condition as compared to the repetition one in L2 and in verbs in both languages.
- Comparison of differences across conditions did not yield significant results.

### Results 3: Source reconstruction



- The significant effects were source localized in:
  - The frontal lobes bilaterally for between-language context
  - The inferior temporal lobes bilaterally for Spanish category switching task
  - The temporal and frontal poles bilaterally for category switching task in Basque

## CONCLUSIONS

- Consistent with our participants being unbalanced bilinguals, responses in L1 were overall faster than responses in L2.
- An early time window (250-350ms) was significant in frontal-central sensors for switches vs repetition in L2 and in verbs in both languages. This time window has been previously shown to be involved in language control [1-3].
- The source level analysis suggests the contribution of the orbitofrontal cortex, which is involved in cognitive control and inhibition during speech production [5]. Furthermore, activity in this area increases bilaterally in response to higher inhibition demands, which is in line with its stronger involvement in L2 switching and verb switching in Basque (L2).
- Future question: How bilingualism impacts on the functional reorganization of language in brain damaged patients?

### REFERENCES

- [1] Blanco-Elorrieta E., Emmorey K., Pykkänen L., 2018, Language switching decomposed through MEG and evidence from bimodal bilinguals.
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- [4] Costa, A., & Santesteban, M. (2004). Lexical access in bilingual speech production: Evidence from language switching in highly proficient bilinguals and L2 learners.
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