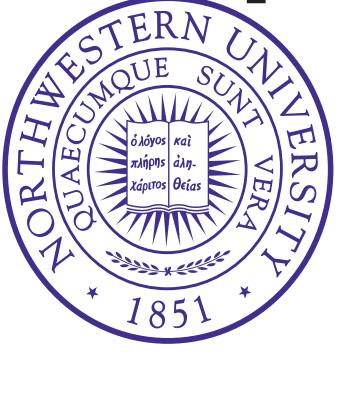


# Aspects of speech production represented in inferior frontal gyrus



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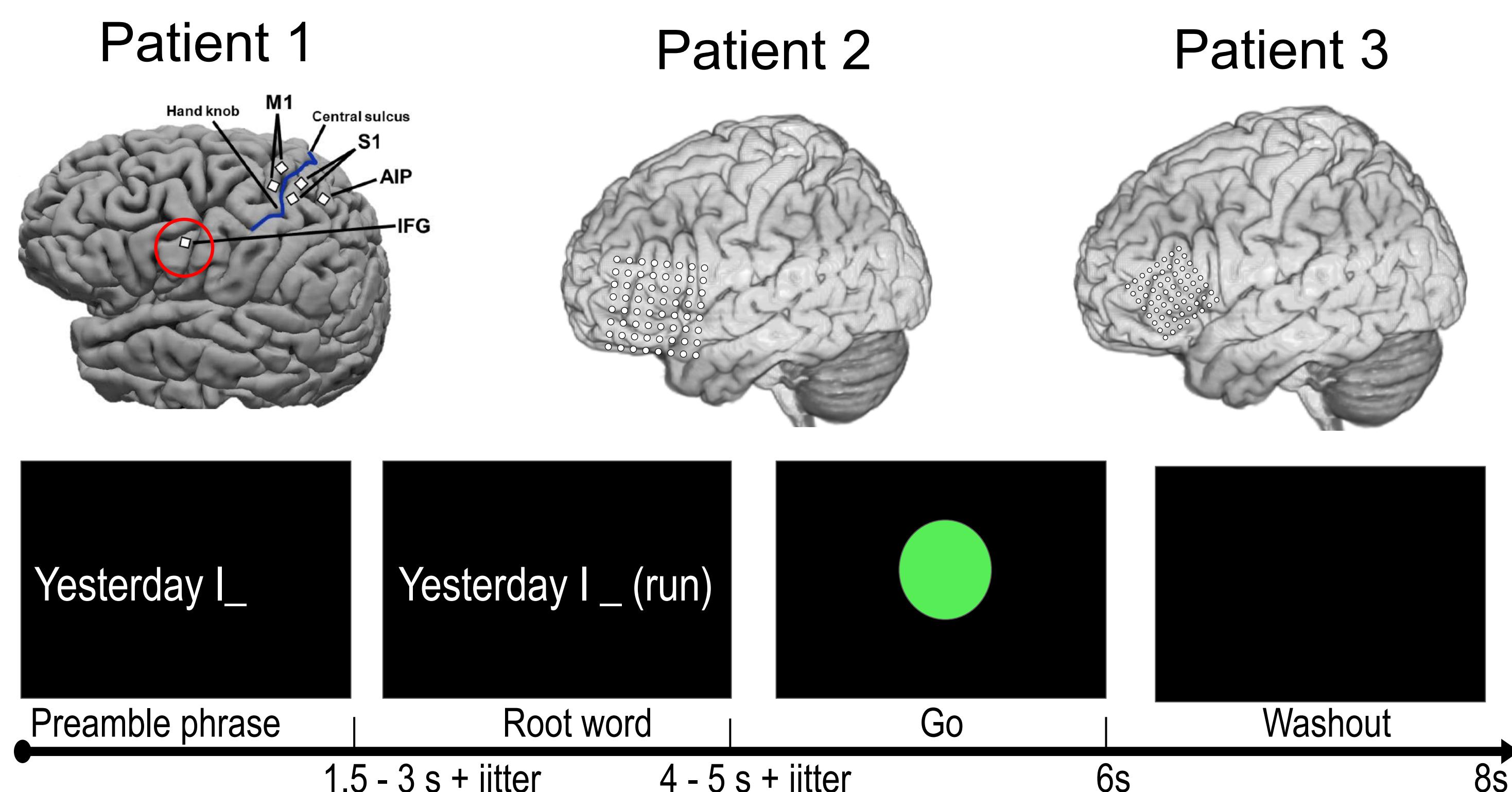
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## Introduction

The inferior frontal gyrus (IFG), Broca's area, has been implicated in speech production, but its precise role in grammatical and morphological processing remains unclear. While previous studies have indicated that IFG might be involved in syntax comprehension and tense processing, the exact nature of its contribution to real-time grammatical processing during speech is still debated. In this study, we recorded broadband neural activity from three participants, two with ECoG arrays over IFG and one with a Utah array on the border of areas 44 and 6v. We implemented a phrase completion task similar to Sahin et al.<sup>1</sup>, which requires the patients to speak out the correctly conjugated verbs given different phrases. The phrases vary in tenses, subject numbers, subject persons and are followed by the root verbs for conjugation. This task intended to elicit possible syntactic processing in IFG, which is explicitly reflected in verb conjugation.

## Participants and Task

- Broadband activity from a human participant (Patient 1) as part of the Reconnecting the Hand and Arm to the Brain (ReHAB) clinical trial and two human participants (Patient 2, 3) during awake craniotomy.
- Patient 1 implanted with 64-channel microelectrode arrays, patients 2,3 implanted with 64-channel surface electrocorticography (ECoG) grid across the left posterior IFG.



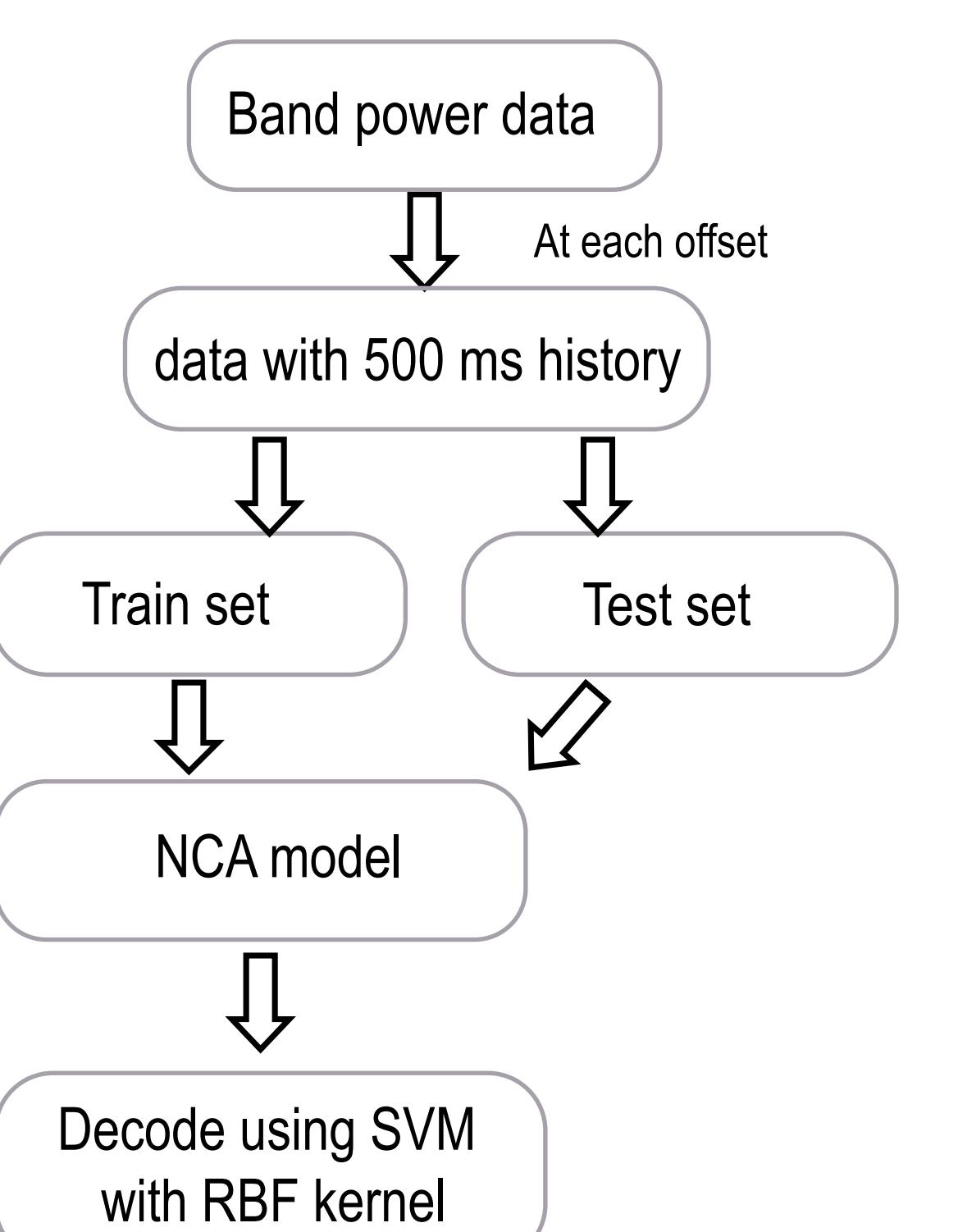
Participants were instructed to read a phrase with one verb missing. This was followed by a root verb that the participant had to conjugate, in agreement with the grammatical context of the verb.

## Conditions:

Tense	Subject Person	Subject Num	Verb morphology
Past	First Person	Singular	Overt inflection
• Yesterday	• I	• He/She	• kick -> kicked
• Last night	• We		• keep -> keeps
• ...			• ...
Present	Third Person	Plural	Null inflection
• Often	• He/She/It	• We	• set --> set
• Never	• They	• They	• fit --> fit
• ...			• ...

## Methods

- Spike band power (patient 1) or high gamma power (patient 2,3) were extracted and binned at 100 ms.
- Data were aligned to different cues.
- Demixed Principal Component Analysis (dPCA) used to separate subspaces based on behavioral conditions.
- At each offset, a decoder was trained on Neighborhood Component Analysis (NCA) features with 500 ms history.



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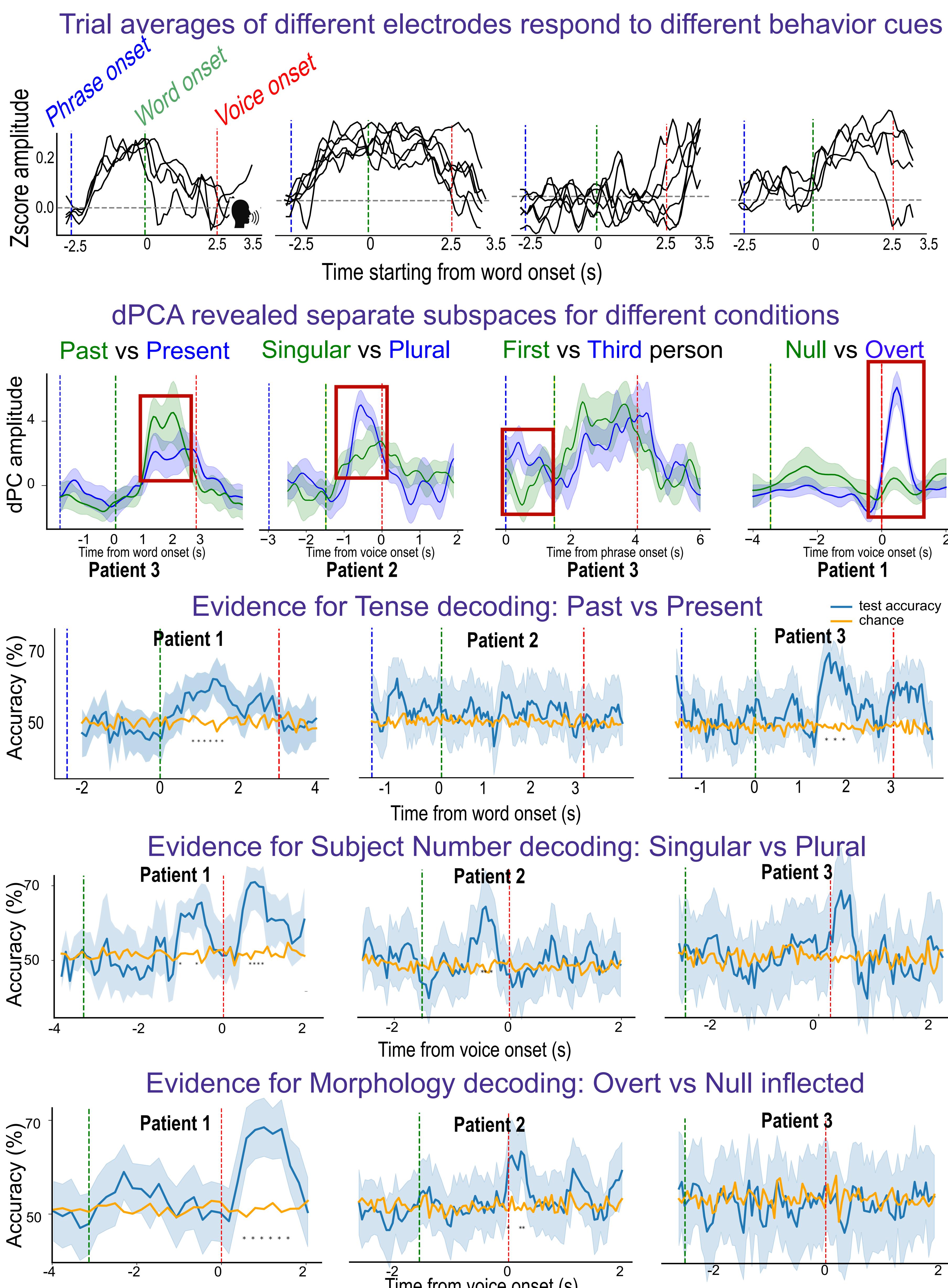
## References

1. Sahin, N. T., Pinker, S., Cash, S. S., Schomer, D., & Halgren, E. (2009). Sequential processing of lexical, grammatical, and phonological information within Broca's area. *Science*, 326(5951), 445-449.

## Results

- Diverse spike band power modulation observed around phrase, word and voice onset in multiple electrodes placed in IFG
- dPCA showed separable activity for different condition on single-trial level.
- Overt inflection related information after speech onset, possibly related to speech monitoring or motor planning.
- Possible tense information after word onset, related to speech production.
- Preliminary evidence for singular vs plural subject prior to speech onset.

## Results



## Summary

- IFG may contain information about Tense, Subject Number and Morphology.
- Significant above-chance accuracy on 2/3 patients showing possible information about tense after word onset that suggests it is production related.
- Significant above-chance accuracy on 2/3 patients after voice onset suggests word inflection in IFG might be related to motor processing/monitoring.
- More data and experiments are necessary to clarify these results.