Investigating neural processing of syllabic and phonemic timescales in spoken language

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Introduction

How the human brain efficiently processes speech remains a major question in neuroscience.

The coupling between ***neural oscillations*** and the rhythm of speech is proposed as a key mechanism.

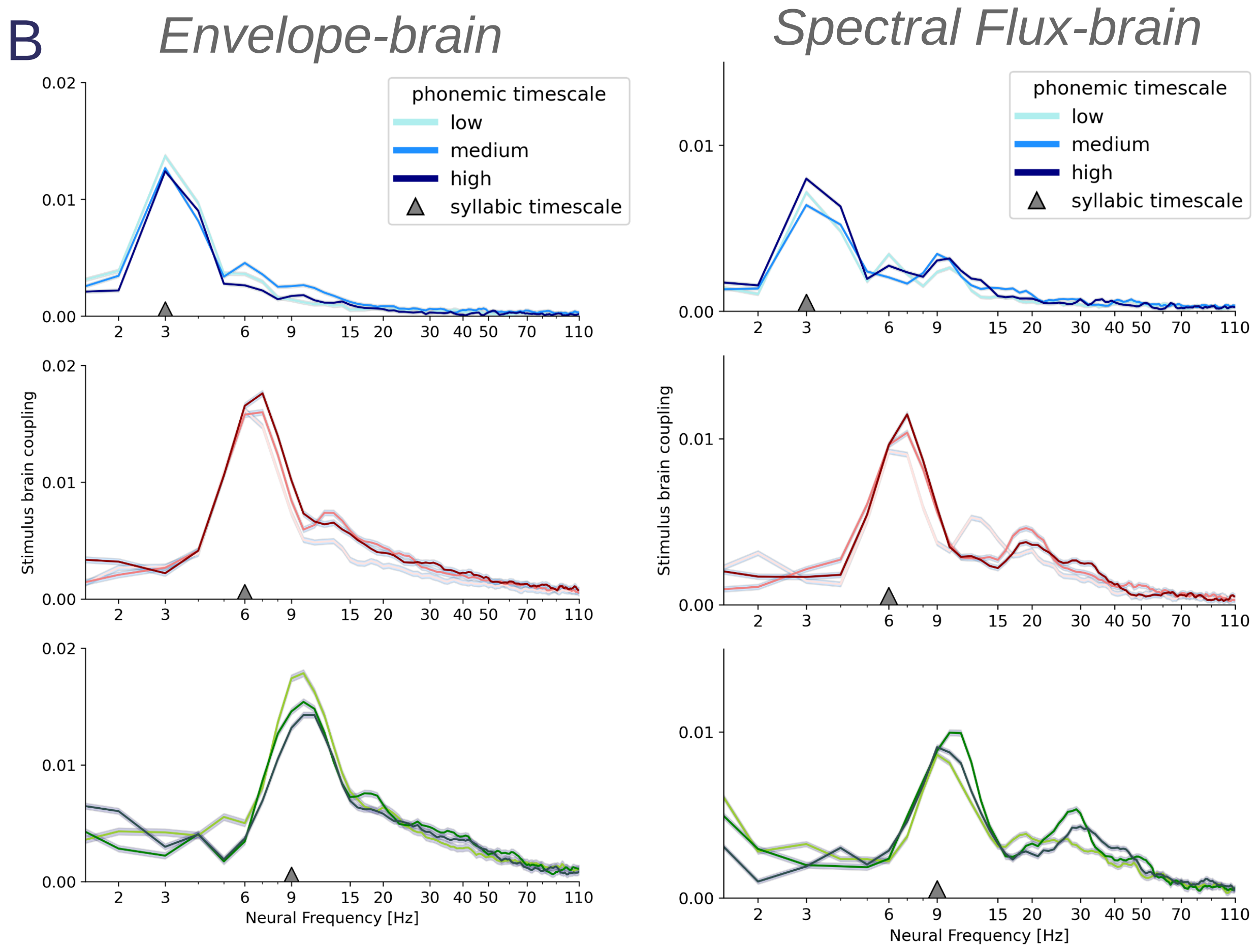
Speech is thought to be sampled in parallel at both the ***syllabic*** and ***phonemic*** timescales reflected by ***Theta*** and ***Gamma*** neural oscillations [1,2].

Theta oscillations in auditory regions track syllabic rhythm during speech perception [3,4].

We investigated the concurrent processing of information at the syllabic and phonemic timescales during speech perception.

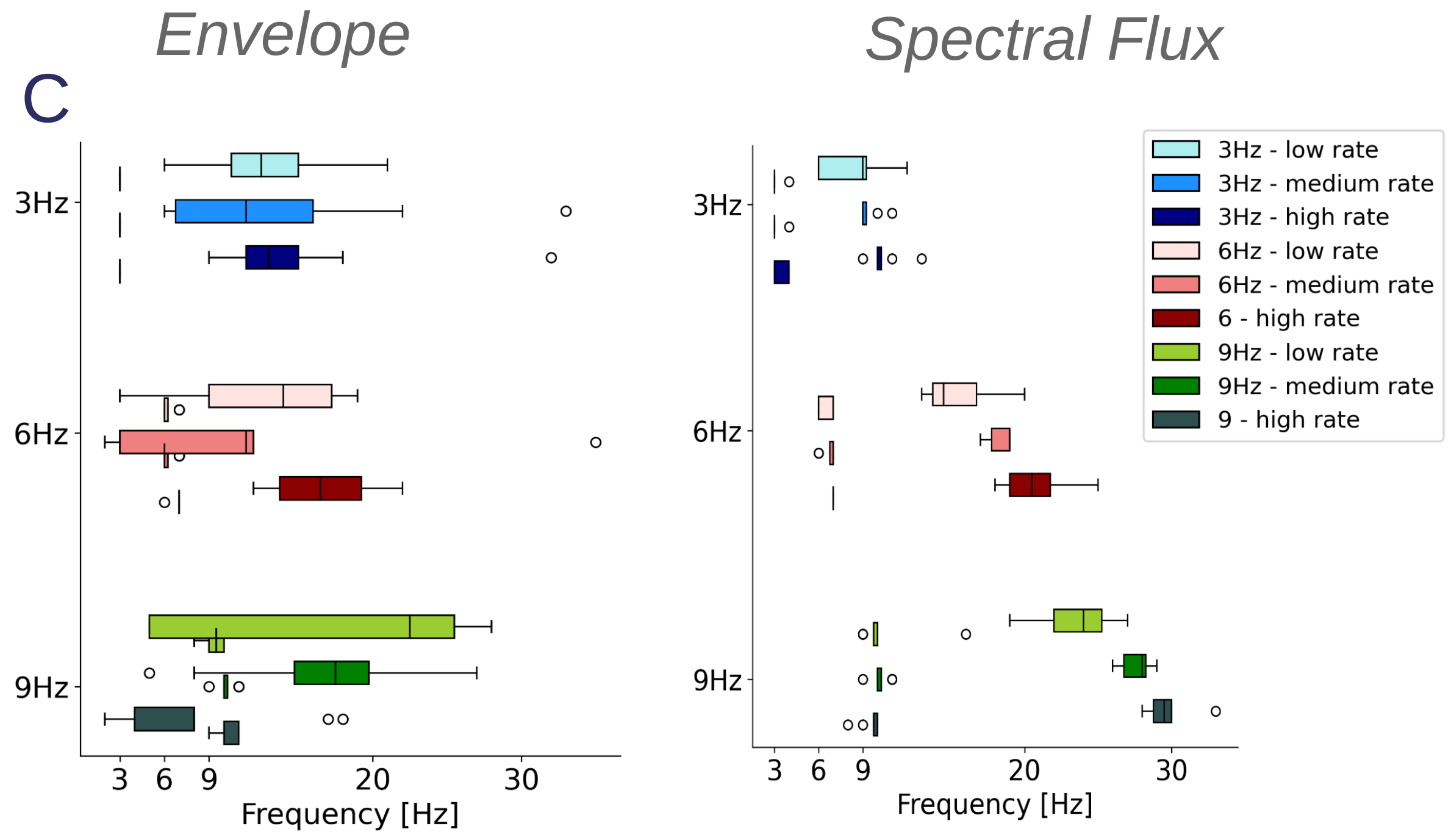
Results

Are syllabic & phonemic timescales reflected in stimulus brain coupling ?



Stimulus brain coupling averaged across electrodes and patients.
The difference between true and permuted coherence values are plotted.

We extracted the frequency values of the 2 local maxima along the coherence spectrum at the individual level



Peak frequency values for 2 local maxima in each condition (n=9) and for each patient (n=10).

Discussion

Syllabic & phonemic timescales are represented in the acoustic properties of the stimuli and can be accurately classified (A).

Multiple acoustic features characterize syllabic and phonemic timescales with differential sensitivity to spectral and envelope cues (A).

Speech tracking adapts to track the syllabic timescales in the theta range (3-9 Hz) (B,C).

Oscillatory activity at higher frequency is sensitive to the phonemic timescale, in particular for spectral flux (B,C).

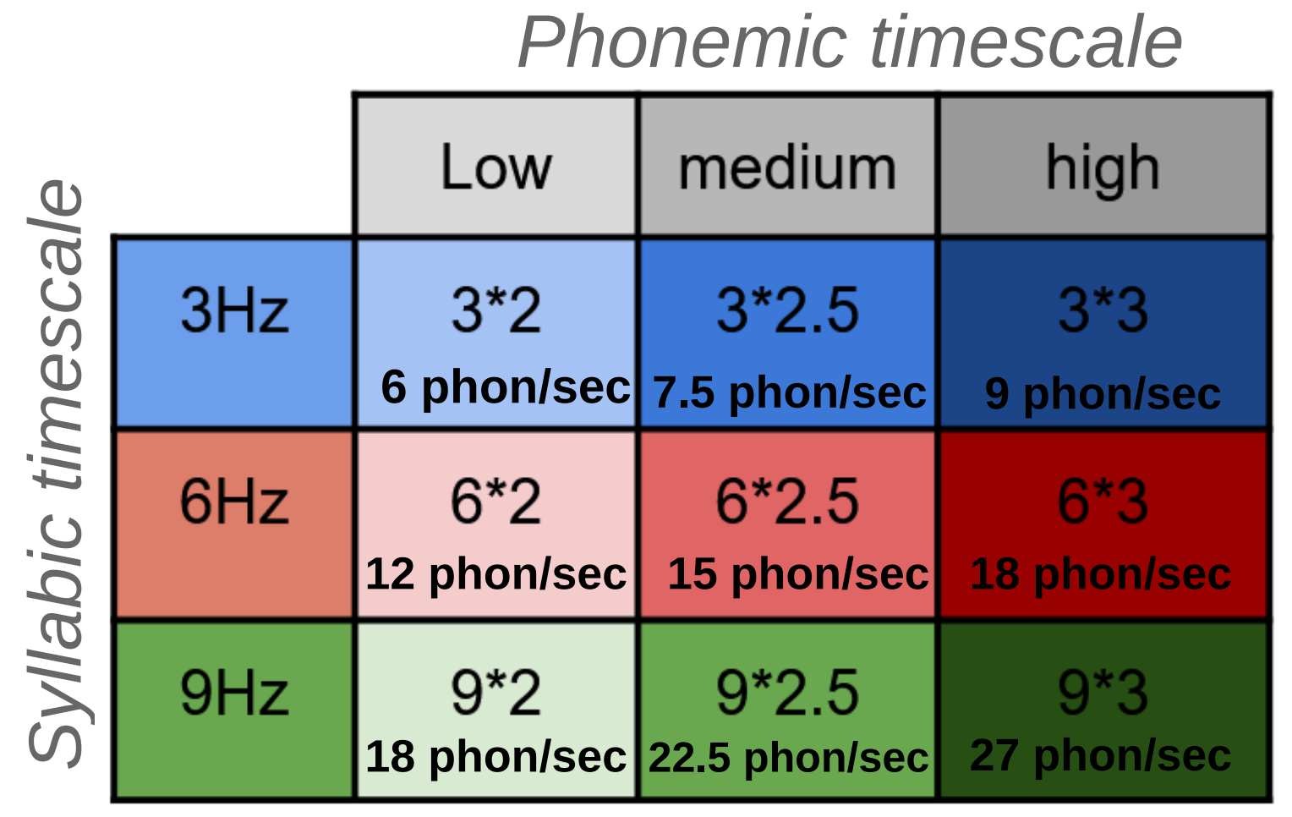
Methods

Stimuli

105 French sentences extracted from *TedTalks*.

Different ***phonemic timescale*** (low, medium, high) corresponding to 2, 2.5 or 3 phonemes per syllable.

Different ***syllabic timescale*** (temporally altered) corresponding to 3, 6 or 9 syllables per second.



Phonemic timescale

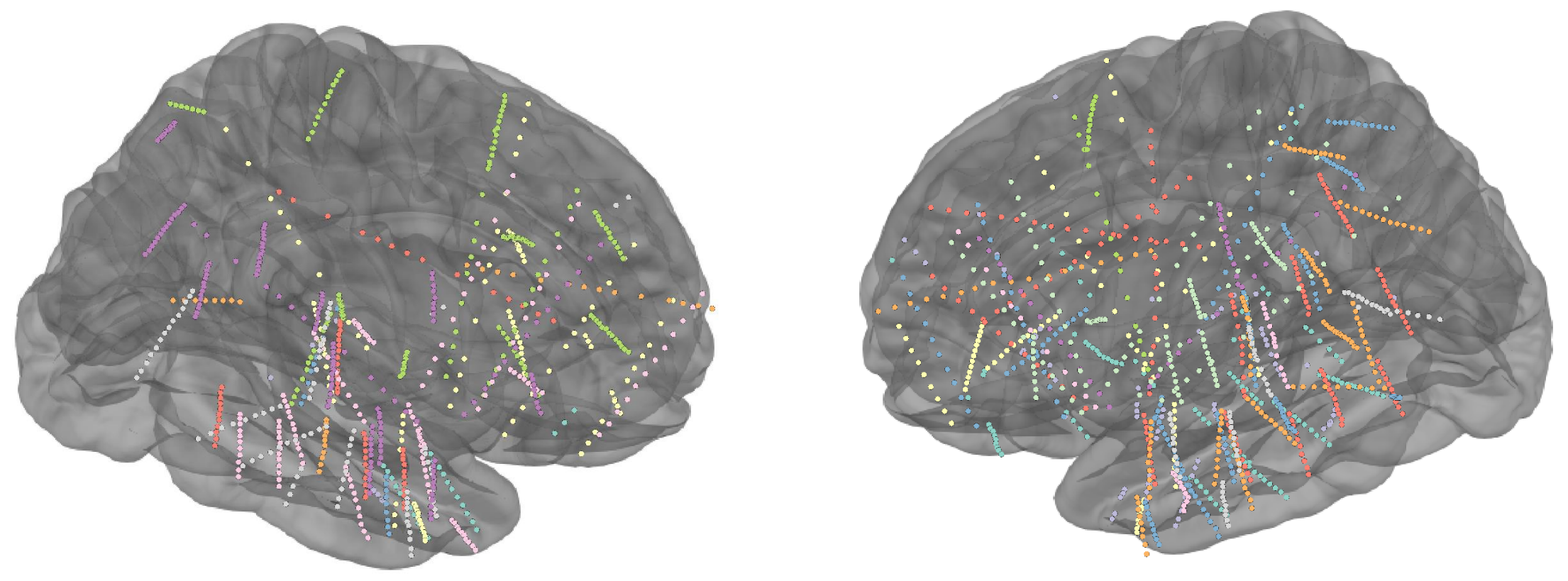
Syllabic timescale

	Low	medium	high
3Hz	3*2 **6 phon/sec**	3*2.5 **7.5 phon/sec**	3*3 **9 phon/sec**
6Hz	6*2 **12 phon/sec**	6*2.5 **15 phon/sec**	6*3 **18 phon/sec**
9Hz	9*2 **18 phon/sec**	9*2.5 **22.5 phon/sec**	9*3 **27 phon/sec**

iEEG Recording

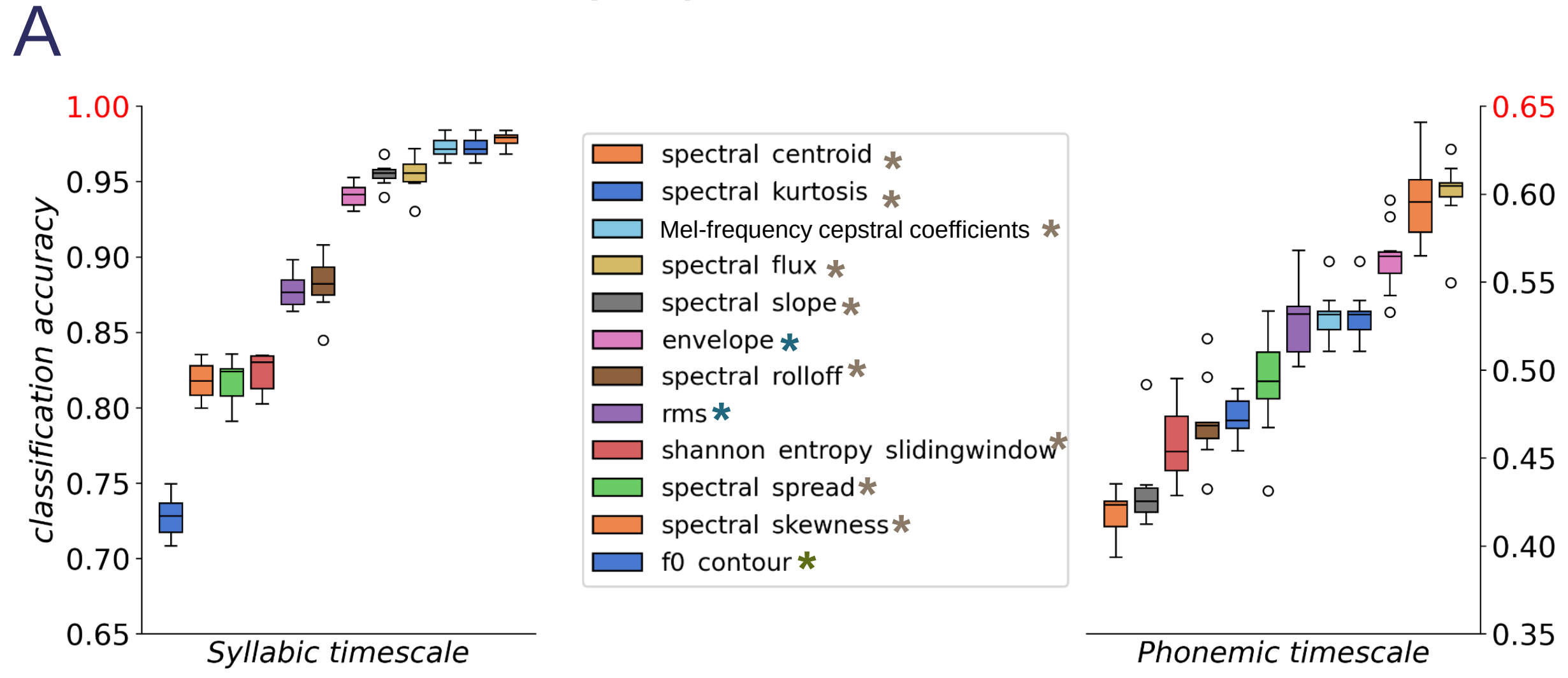
10 French epileptic patients underwent intracranial recording (iEEG).

They performed a speech comprehension task with repetitions.



iEEG electrodes localisations. Each dot represent one recording site. Each colour represent data from one of the ten patients. Topographies are represented within a common template brain in a MNI space.

Are syllabic & phonemic timescales reflected in the acoustic properties of the stimuli?



Classification of the stimuli based on the phonemic and syllabic timescales as reflected by different acoustic features (power spectrum).

Different classification accuracies for syllabic and phonemic timescales

Different features as best predictors for syllabic and phonemic timescales

Acknowledgements

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References

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