Neural Responses to Narrative Speech Differentiate Patients with Disordered Consciousness

Ivan Iotzov [1], Brian C. Fidali [2], Agustin Petroni [1], Mary M. Conte [2], Nicholas D. Schiff [2], Lucas C. Parra [1]

[1]City College of New York, New York, New York. [2] Laboratory of Cognitive Neuromodulation, The Feil Family Brain and Mind Research Institute, Weill Cornell Medicine, New York, New York

Disorders of Consciousness (DOC)

Incoming patients with disordered consciousness must be categorized to determine treatment course

Vegetative State (VS)
- Complete absence of self or environmental awareness
- Lack of stimulus driven response outside of startle
- No command following

Minimally Conscious State (MCS)
- Inconsistent awareness of self or environment
- Visual and auditory stimulus orienting response
- Inconsistent command following

Additionally, MCS can be subdivided into MCS+, MCS-, and emerging MCS (eMCS). Correct clinical assessment of disordered consciousness is essential to better clinical outcomes for patients. Clinical diagnoses rely on physician assessment, which is difficult and can lead to misdiagnosis rates as high as 41% (Schnackers et al., 2009).
Therefore, it is important to find objective neural measures of cognitive processing in order to more effectively treat patients and allocate limited health resources.

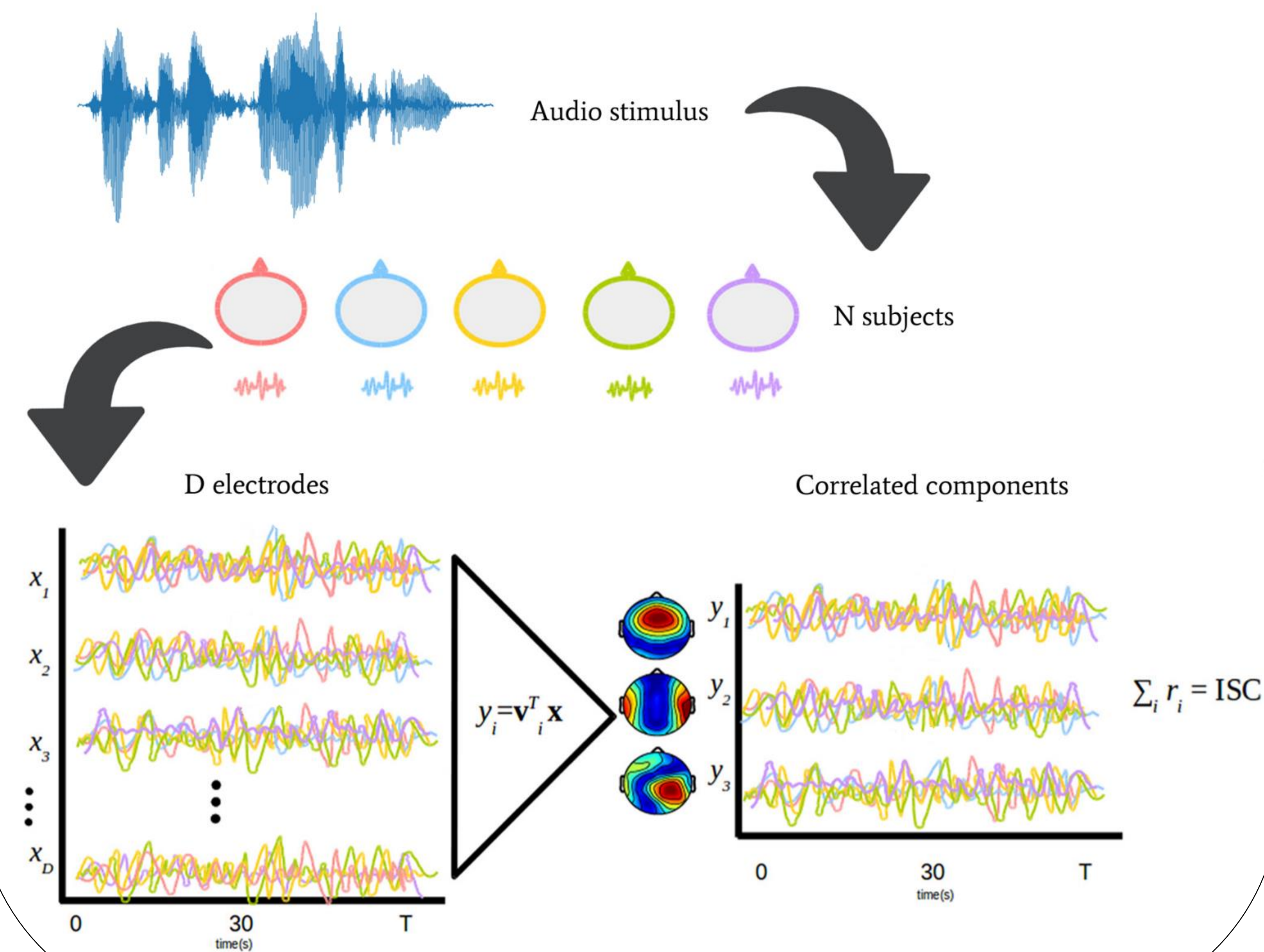## Inter-subject correlation (ISC): A measure of neural variability

Inter-subject correlation (ISC)
14 Healthy and 20 DOC subjects presented with 2 audio narratives, both normal and backwards. EEG responses were recorded and compiled from all subjects to construct ISC model.
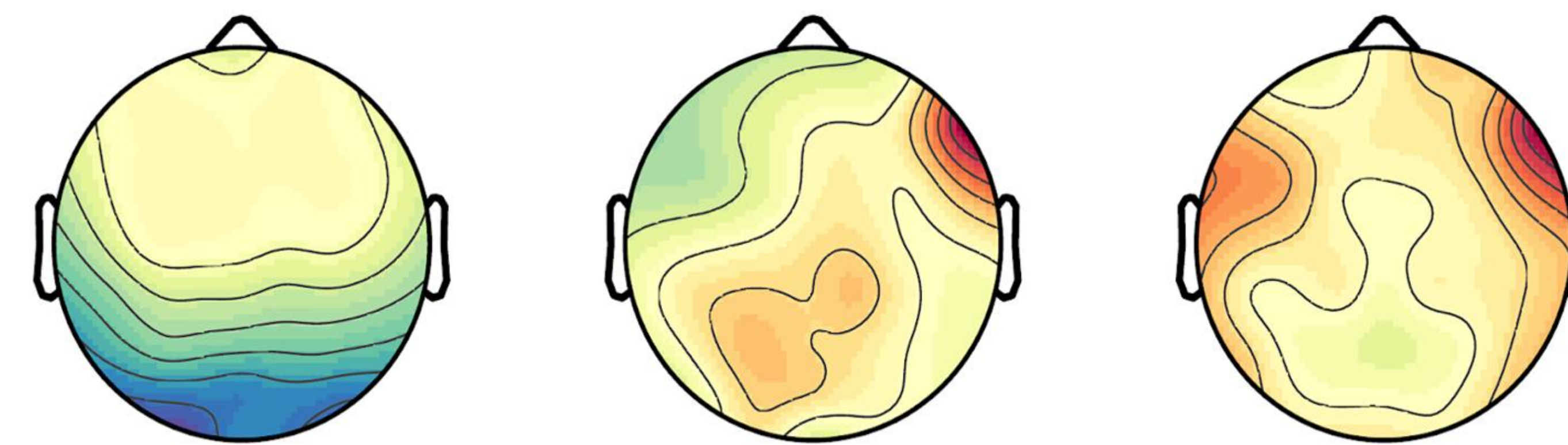
Implicated in:
- Memory (Cohen et al., 2016)
- Attention (Ki et al., 2016)
- Engagement (Dmochowski et al., 2014)

Audio consisted of 2 narratives, an *Alice in Wonderland* audiobook excerpt, and a stand-up comedy routine, *Pieman*.
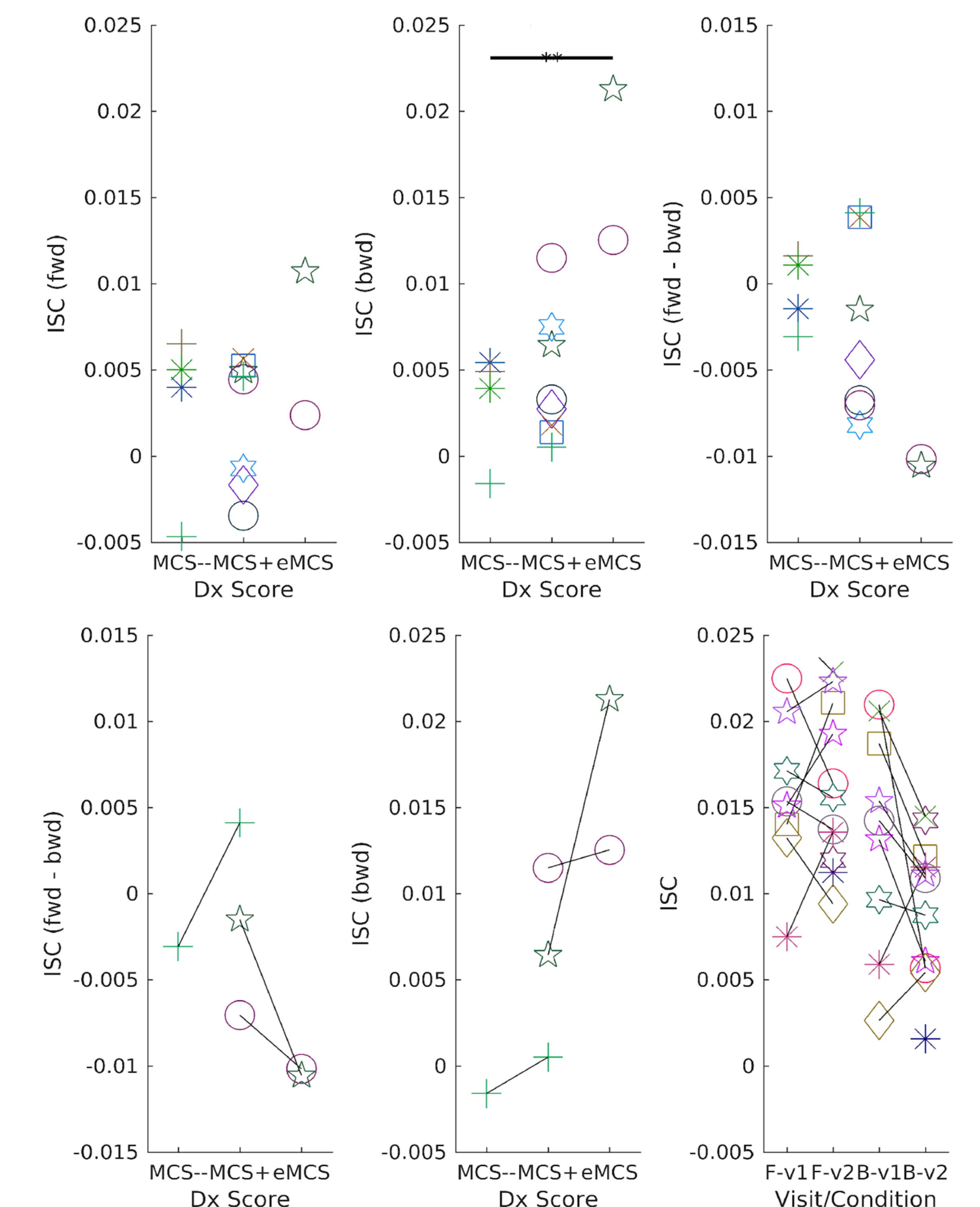

Correlated components are consistent across subjects and studies
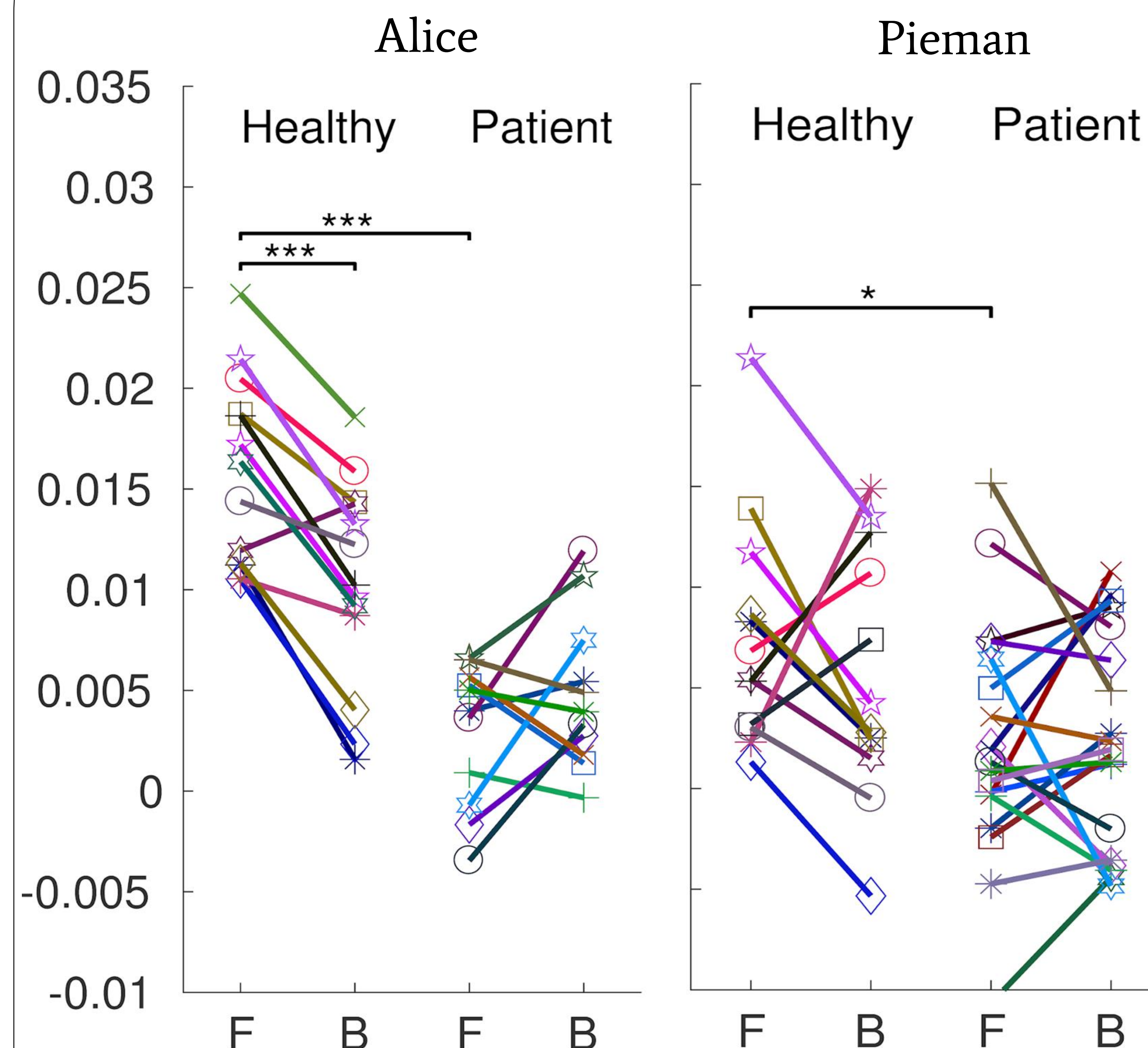
Component 1 **Component 2** **Component 3**

Correlated components were calculated for all subjects using both forward and backward playback of the *Alice* stimulus. ISC scores were then calculated using these three correlated components. The components found are consistent with those in previous studies using auditory stimuli (Cohen et al., 2016).

Inter-subject correlation is higher in healthy subjects than in DOC subjects

Healthy subjects showed significantly higher ISC than DOC subjects, as well as showing higher ISC in the forward condition compared to backward for the *Alice* stimulus, but not for *Pieman*. Additionally, DOC patients did not show a stronger ISC response for forward vs. backward playback, and in fact show slightly higher ISC for the backward condition.

ISC during backward playback is predictive of DOC diagnosis

Discussion

The ISC procedure provides a novel method that can differentiate patients with disordered consciousness. Importantly, this method uses naturalistic speech, which is both more salient to patients and more representative of the type of auditory processing in everyday situations. The scores of DOC patients on the backwards listening task appear to be correlated with their clinical diagnosis but are not of interest to healthy subjects. This could be due to the novelty of the backwards stimuli, or is perhaps a reflection of the auditory brainstem response being relatively stronger in DOC subjects due to lack of interference. These data show the potential of ISC of neural activity during audition as a biomarker for DOC, but further research is needed to determine optimal stimuli and testing procedures, as shown by the varied results between stimuli.

References

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