

Neural bases of illusory acoustic texture perception

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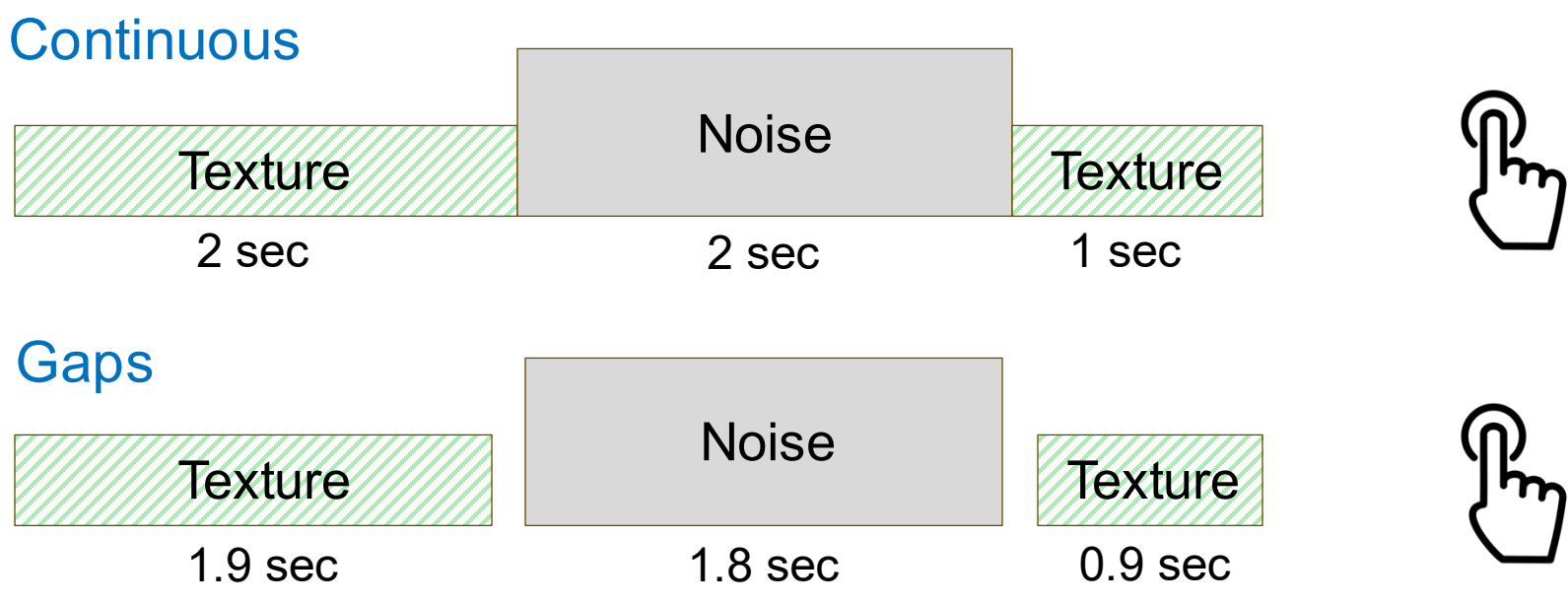


BACKGROUND

- Continuity illusions arise when a sound is perceived to continue through noise, even when physically absent [1].
- Neural correlates for pure tone illusory continuity have been found in macaque A1 [2].
- Illusory vowel and phoneme perception are associated with activity in speech-sensitive superior and middle temporal gyri [3,4].
- Multi-second illusory continuity has been reported for statistically-defined acoustic textures [5].
- For veridical texture perception, medial temporal lobe BOLD activity and its functional connectivity with auditory cortex is modulated by the prominence of texture statistics [6 and POSTER 215].
- We investigate whether illusory perception of multi-second texture continuity illusion draws on brain areas beyond sensory cortex.

METHOD

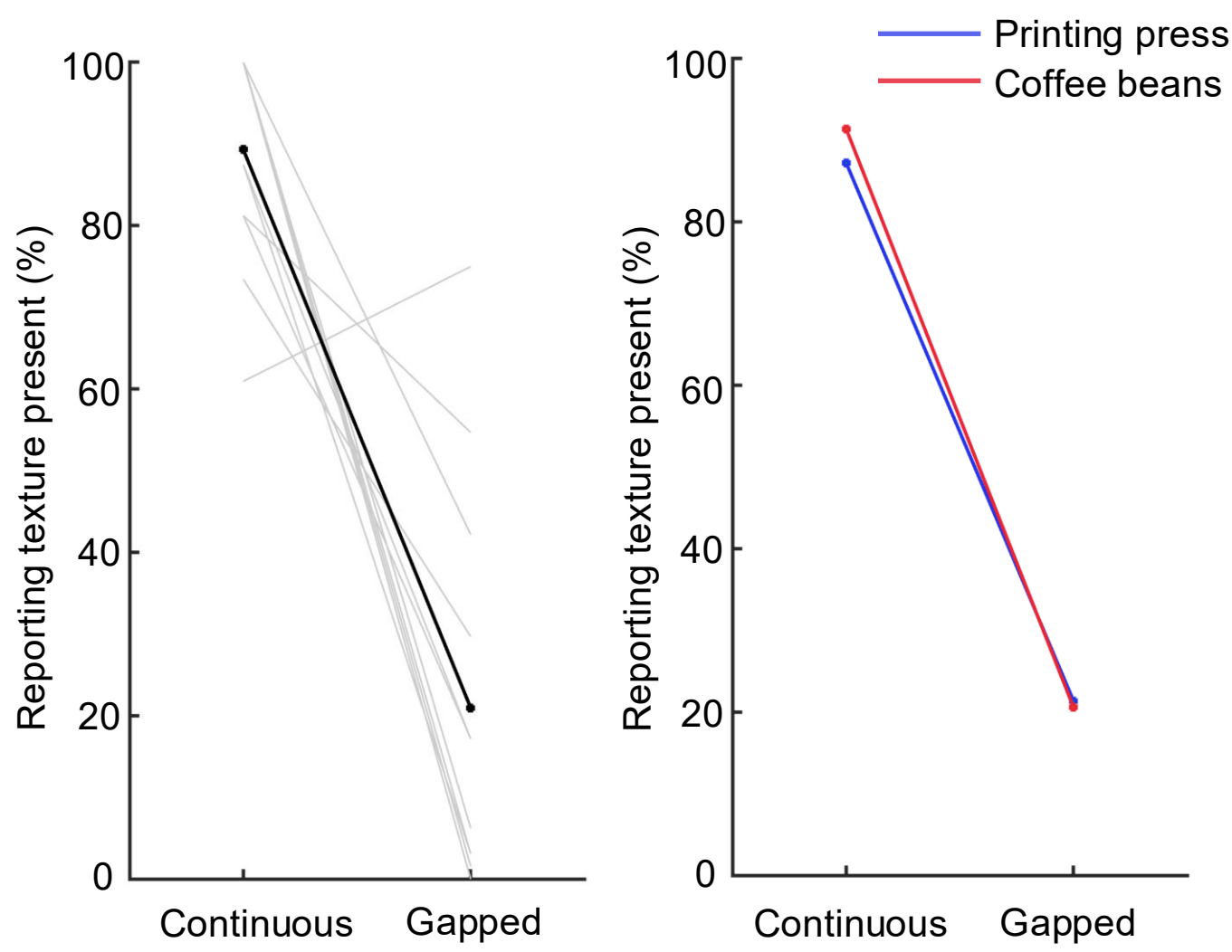
- Participants were 12 patients undergoing intracranial monitoring for localisation of epileptic foci.
- Stimuli were textures synthesized using the model of [5] based on summary statistics from recordings of (a) a printing press (b) coffee beans being poured.
- Trial-unique exemplars were interrupted (replaced) by white noise loud enough to mask them, either in a continuous fashion or (to break the illusion [7]) with silent gaps abutting the noise.



- After each of the 128 trials (conditions randomly interleaved) participants reported whether or not they heard the texture continue during the noise.

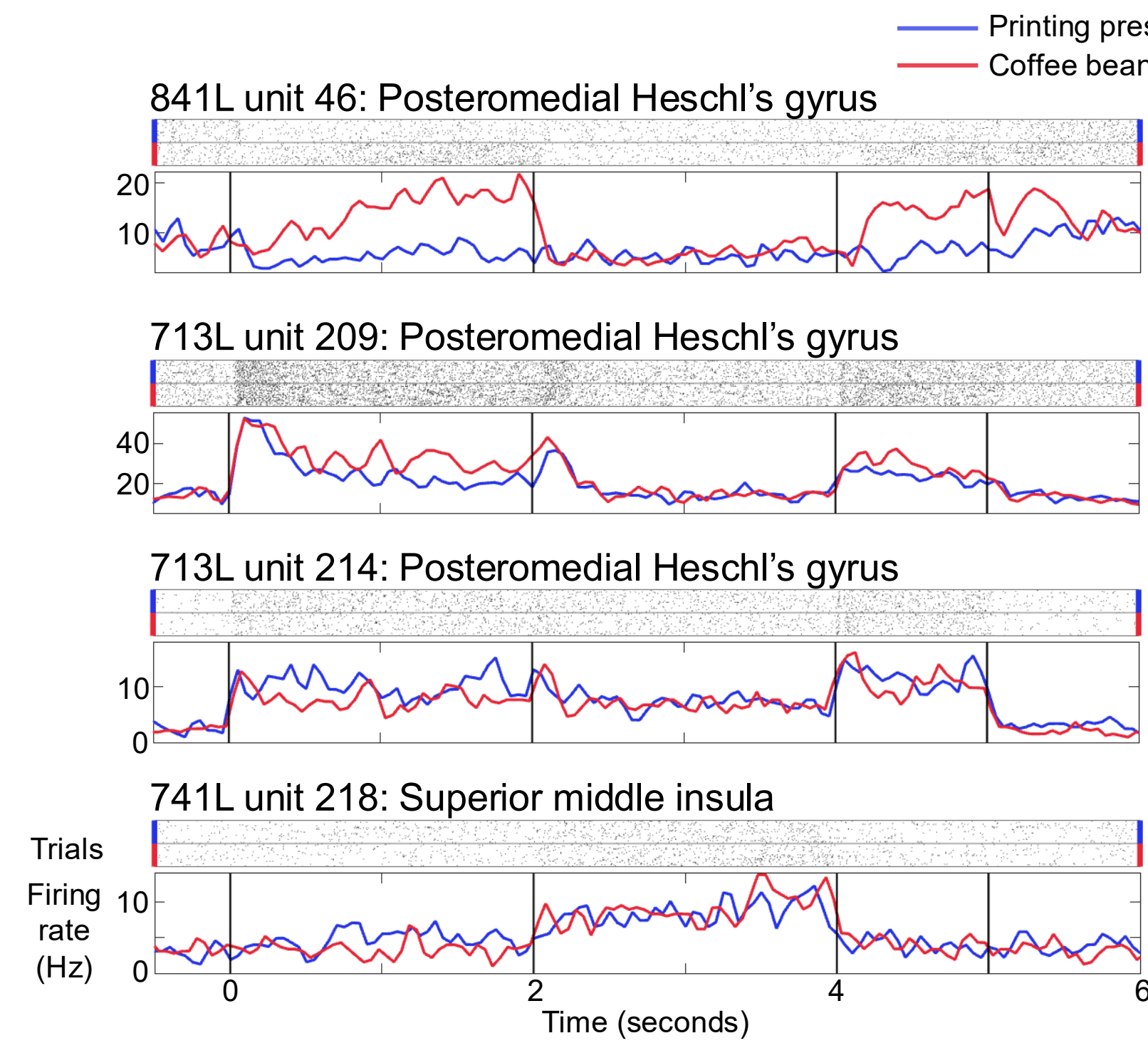
BEHAVIOUR

- Significant reduction in reporting of illusion when gaps present.
- Similar reporting of illusion for both textures.



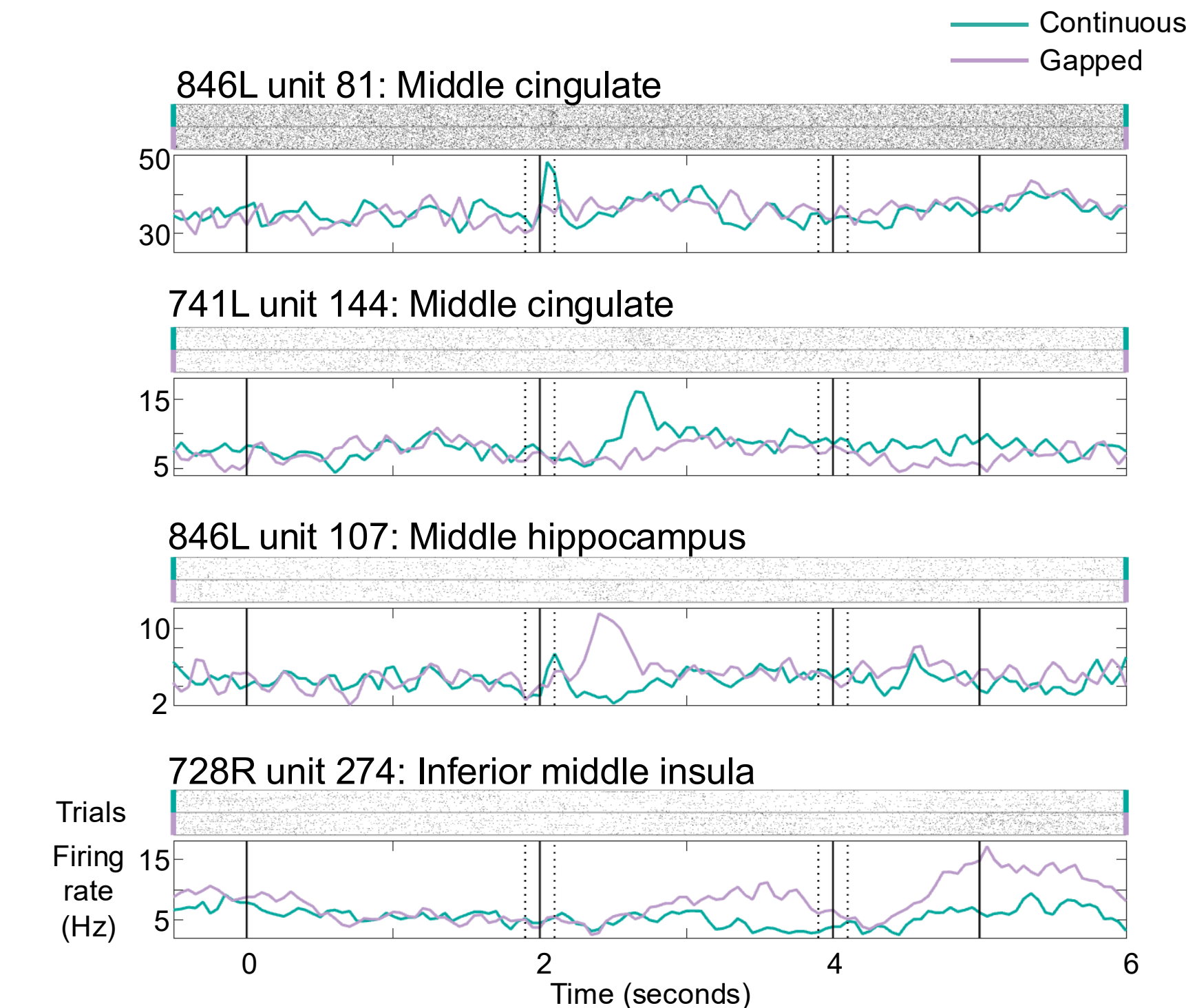
SINGLE UNIT EXAMPLES

By texture (continuous trials only)



- Units tuned to a particular texture did not maintain that preference during illusory continuity.

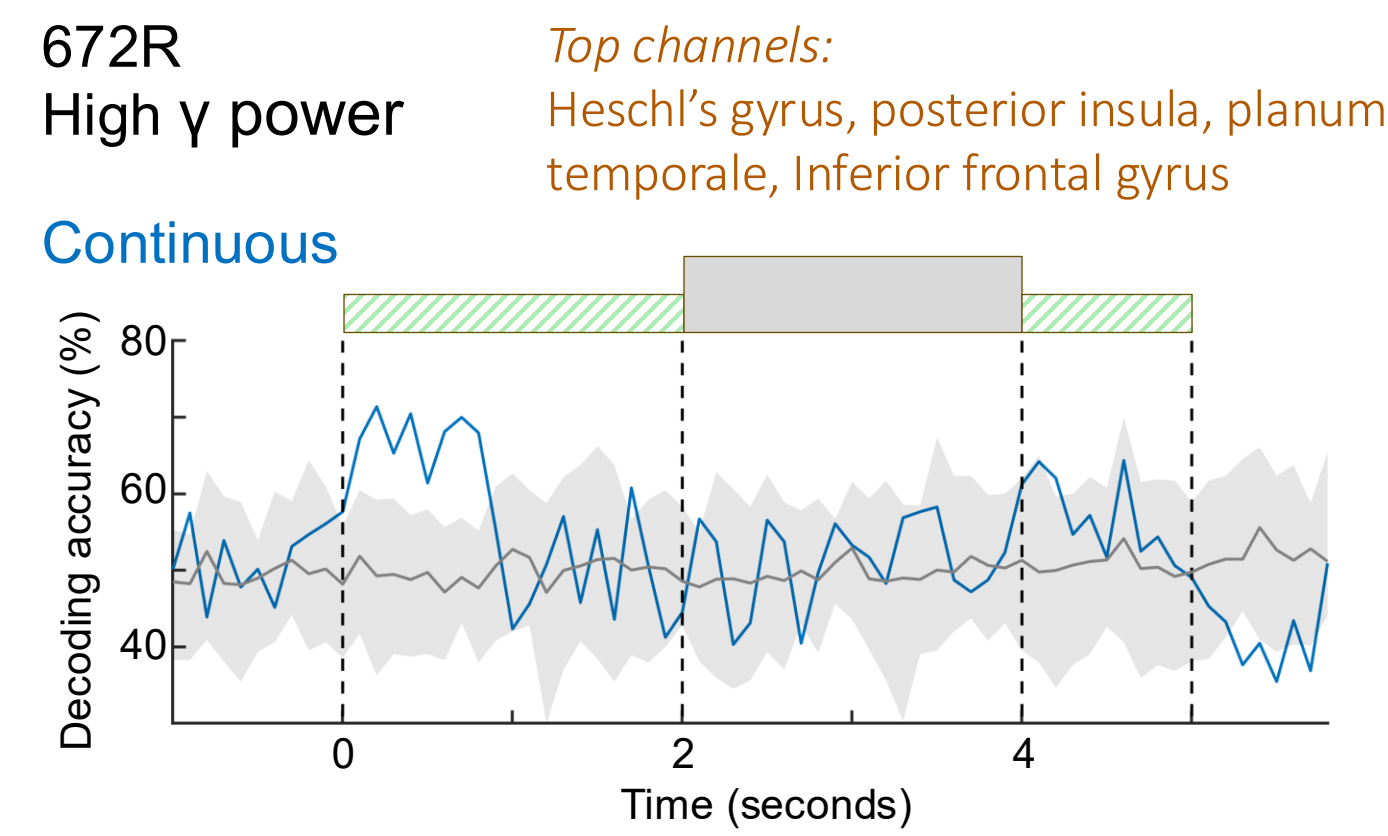
By condition (both textures)



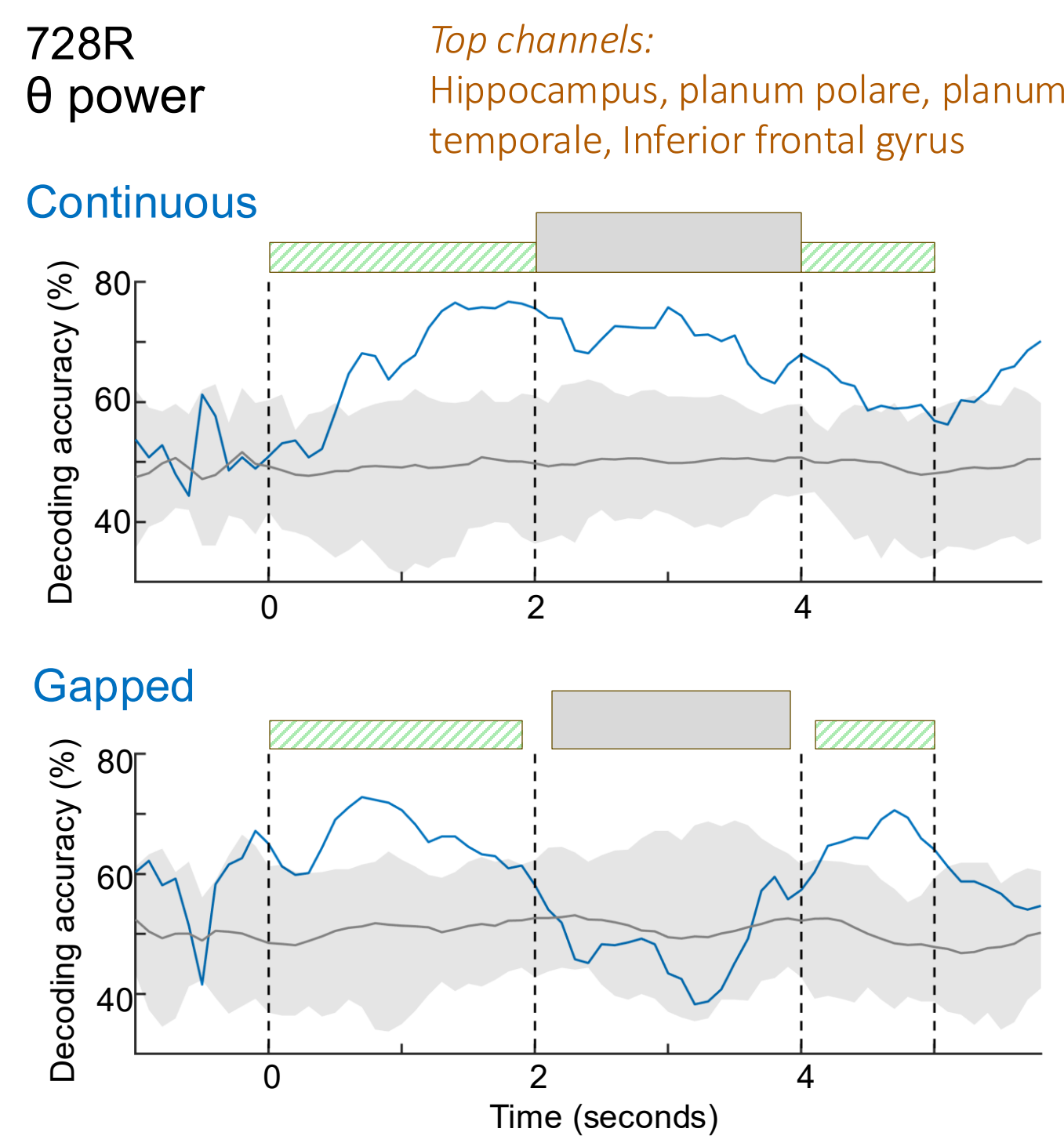
- Units distinguishing between continuous and gapped trials may reflect acoustics, perception, decision, or response.

TEXTURE DECODING ANALYSES

Examples



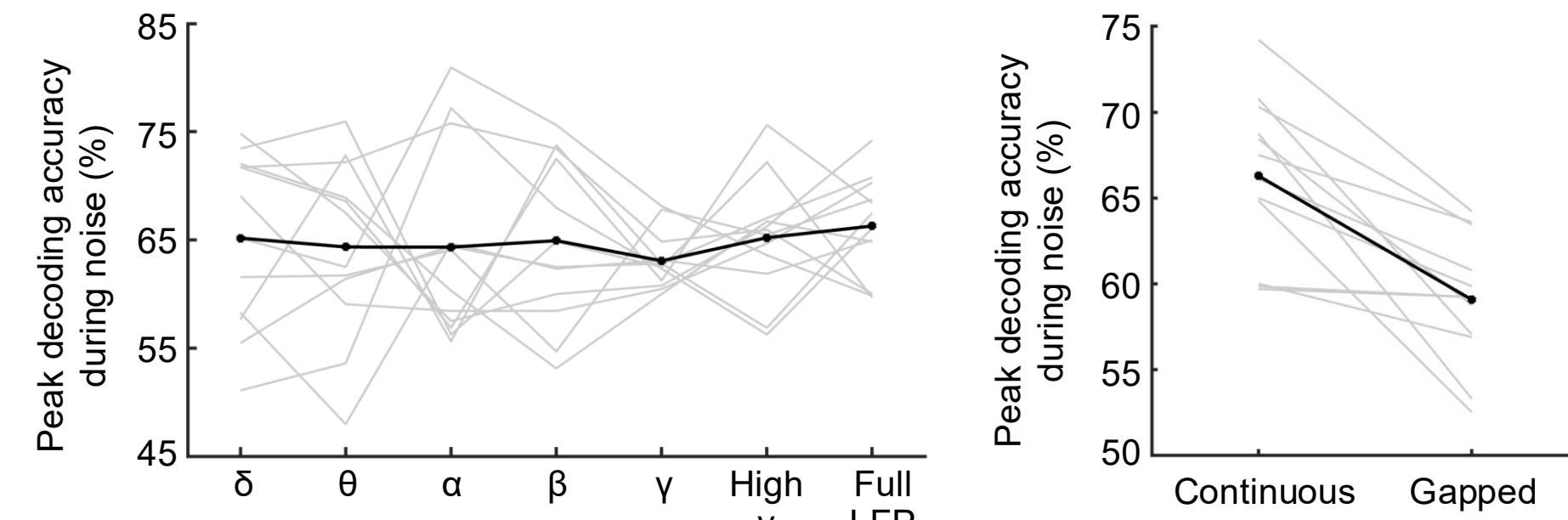
- Initial texture presentation decoded.



- Texture decoded during noise (continuous condition only).

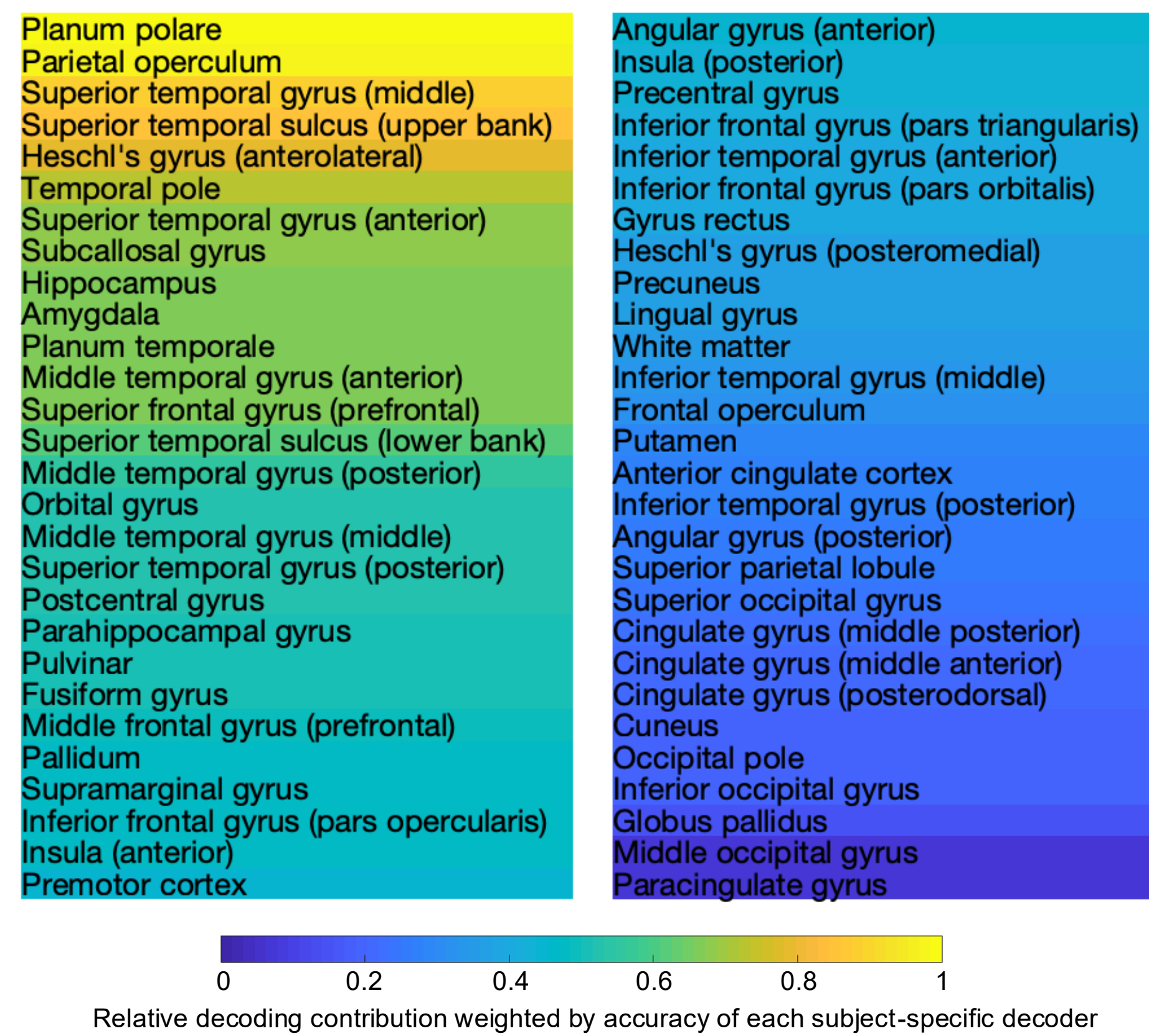
Mean and 95% confidence interval of null distribution shown in grey.

Decoding quality and consistency



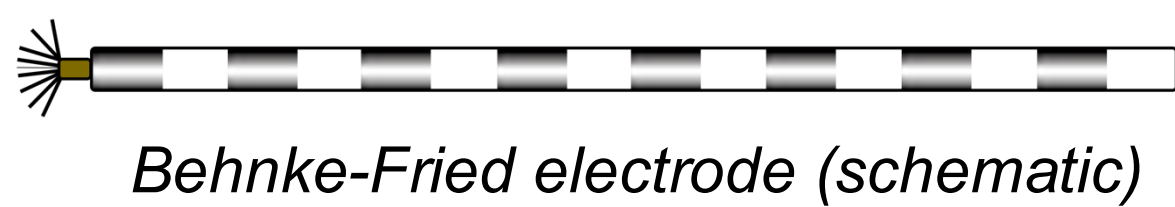
- Full LFP gives best the decoding accuracy, which is greater in the continuous than the gapped case.

Regional weights in full-LFP decoders



RECORDING AND ANALYSIS

- Intracranial activity recorded with depth electrodes, a subset of which had high-impedance microwires extruded at tip for single neuron recording.
- Spike-sorting using Higher-Order Spectral Decomposition [8].
- Participant-specific decoding of presented texture from local field potential (LFP) activity using cross-validated linear support vector machines.
- Separate decoders using power in δ (1-4 Hz), θ (4-8 Hz), α (8-12 Hz), β (12-30 Hz), γ (30-70 Hz), high γ (70-150 Hz) bands, and another using full LFP.
- Iterative selection of informative channels to optimise decoding.



SUMMARY

- Single units in primary auditory cortex and insula preferred different acoustic textures but did not reflect illusory texture continuity.
- Single units in cingulate, hippocampus, and insula distinguished between continuous and gapped trials.
- Features (varying across participants) of the LFP carried information about textures, even when they were replaced by white noise.
- The full LFP in anterolateral temporal cortex most reliably contributed to decoding illusory texture.
- The illusory percept and the ability to decode texture from noise was broken when silent gaps were inserted between texture and noise.

[1] Miller, GA & Licklider, JCR. *JASA*, **22**, 167-173, 1950. [2] Petkov, CI et al. *Neuron*, **54**(1), 153-165, 2007. [3] Heinrich, A et al. *J Cog Neurosci*, **20**(10), 1737-1752, 2008. [4] Leonard, MK et al. *Nat Comms*, **7**(13619), 2016. [5] McWalter, R & McDermott, JH. *Nat Comms*, **10**(5096), 2019. [6] Mohammadi, Y et al. 10.1101/2025.06.17.660096 [bioRxiv preprint], 2025. [7] McDermott, JH et al. *Nat Neurosci*, **16**(4), 2013. [8] Kovach, CK et al. 10.13140/RG.2.2.28352.40967 [ResearchGate preprint], 2023.

