Neural speech tracking

How brains make sense of speech

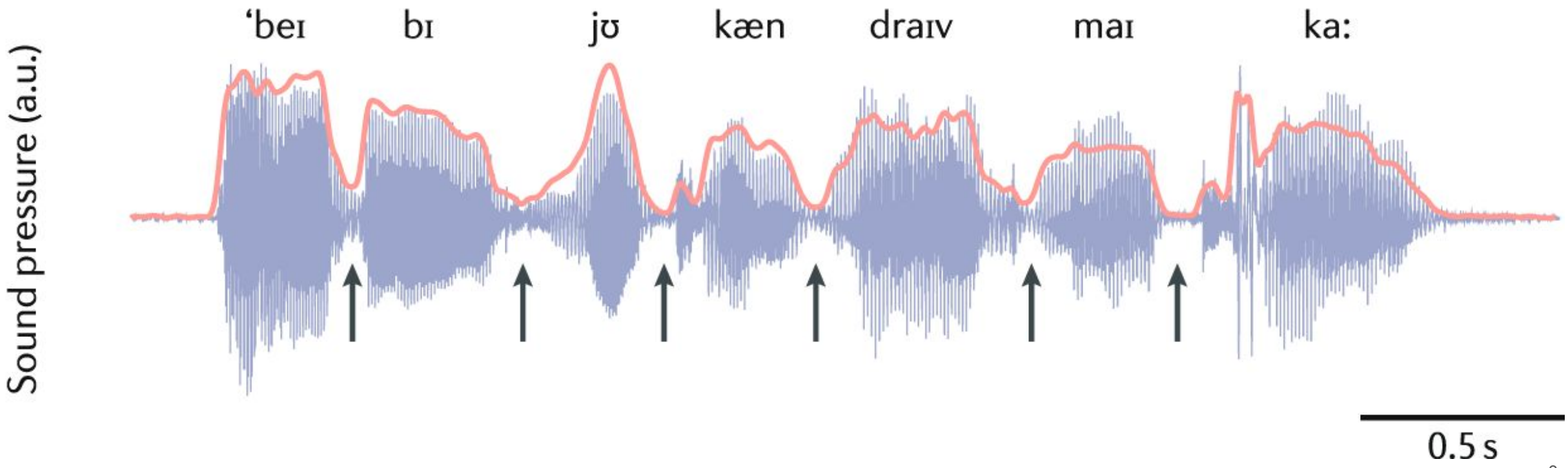
Speech tracking/comprehension -
a complex task solved without effort (usually)

sincetherearenowordboundariesinspokenlanguagethedifficultywefeelinreadingandunderstandingtheabov
eparagraphprovidesasimpleillustrationofoneofthemaindifficultieswehavetoovercomeinordertounderstan
dspeechratherthananeatlyseparatedsequenceofletterstringscorrespondingtothephonologicalformofword
sthespeechsignalisacontinuousstreamofsoundsthatrepresentthephonologicalformsofwordsinadditionth
esoundsofneighboringwordsoftenoverlapwhichmakestheproblemofidentifiyingwordboundariesevenhard
er

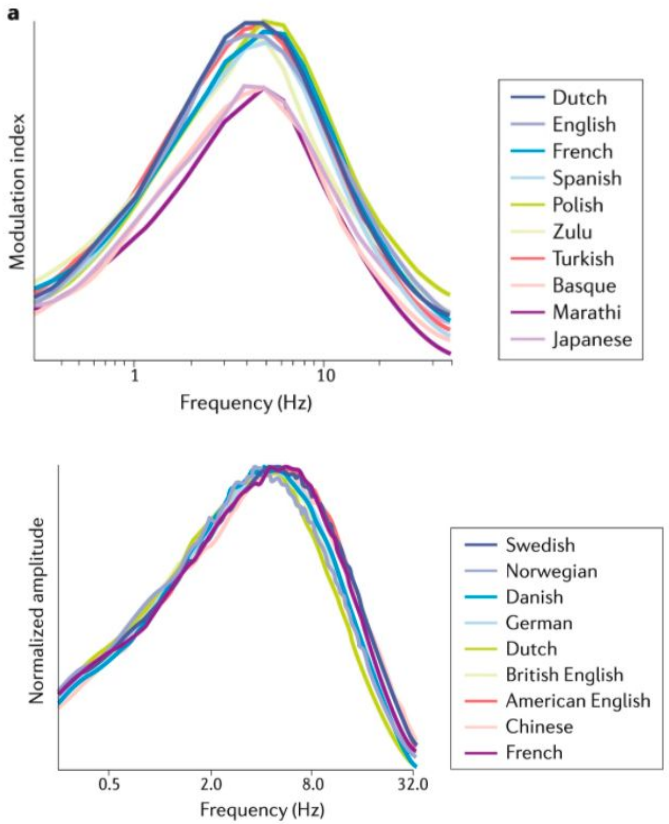
Poeppel & Assaneo, 2020

Acoustic envelope modulations coincide with the production rate of syllables

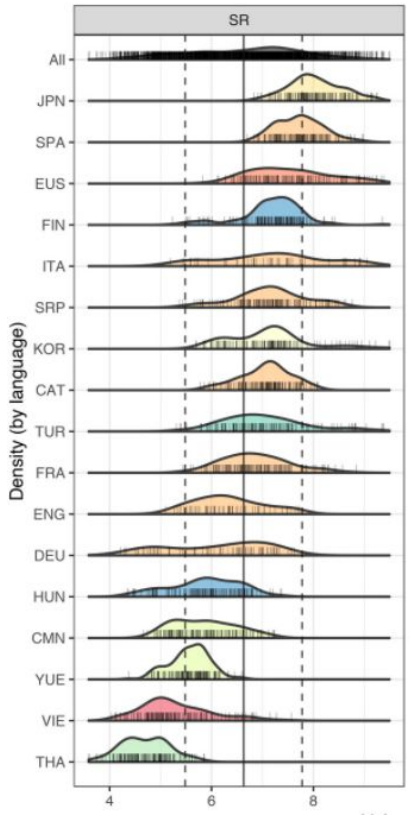
Baby you can drive my car



Poeppel & Assaneo, 2020



Assaneo & Poeppel, 2020



Coupé et al., 2019

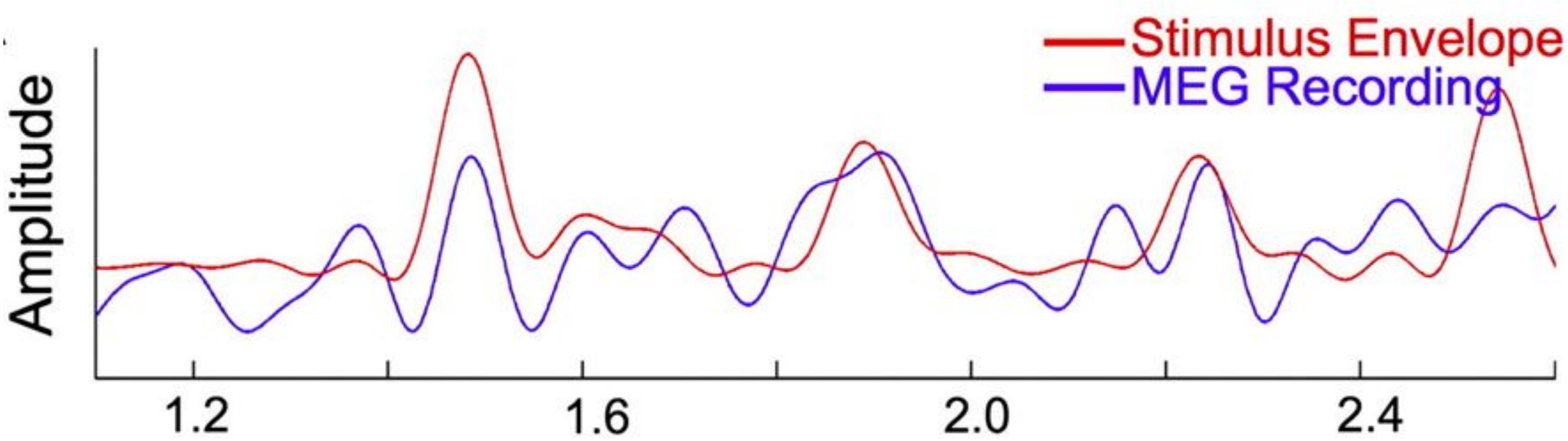
Acoustic envelope modulations

➔ similar across languages

Syllabic rates

➔ dissimilar across languages

Brain activity tracks the acoustic envelope of an audio signal



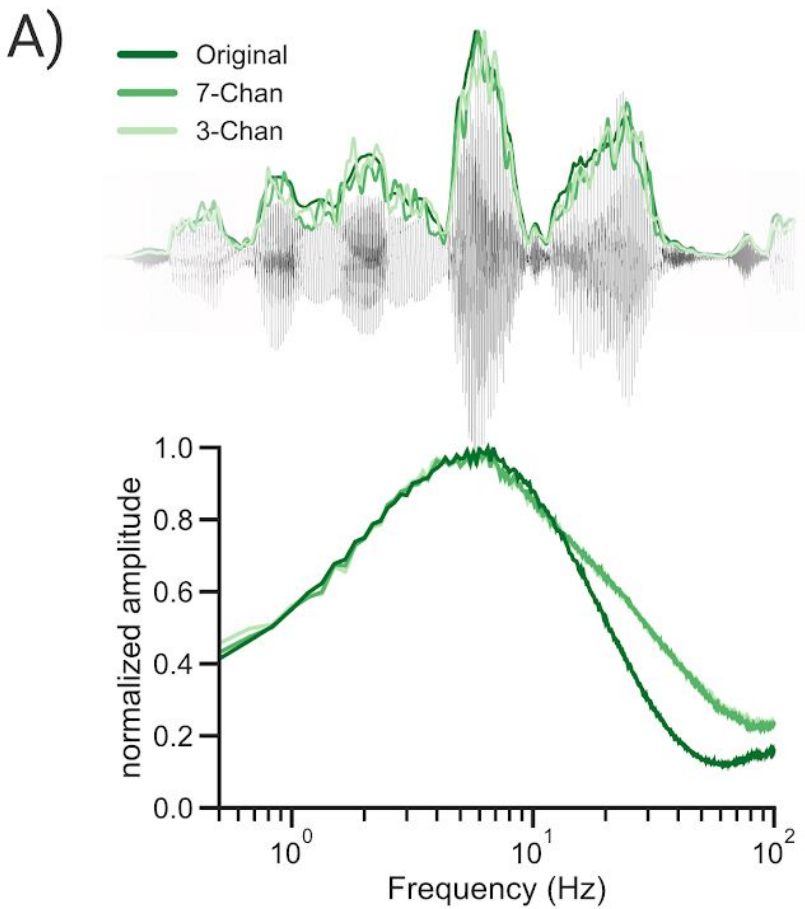
Doelling et al., 2014

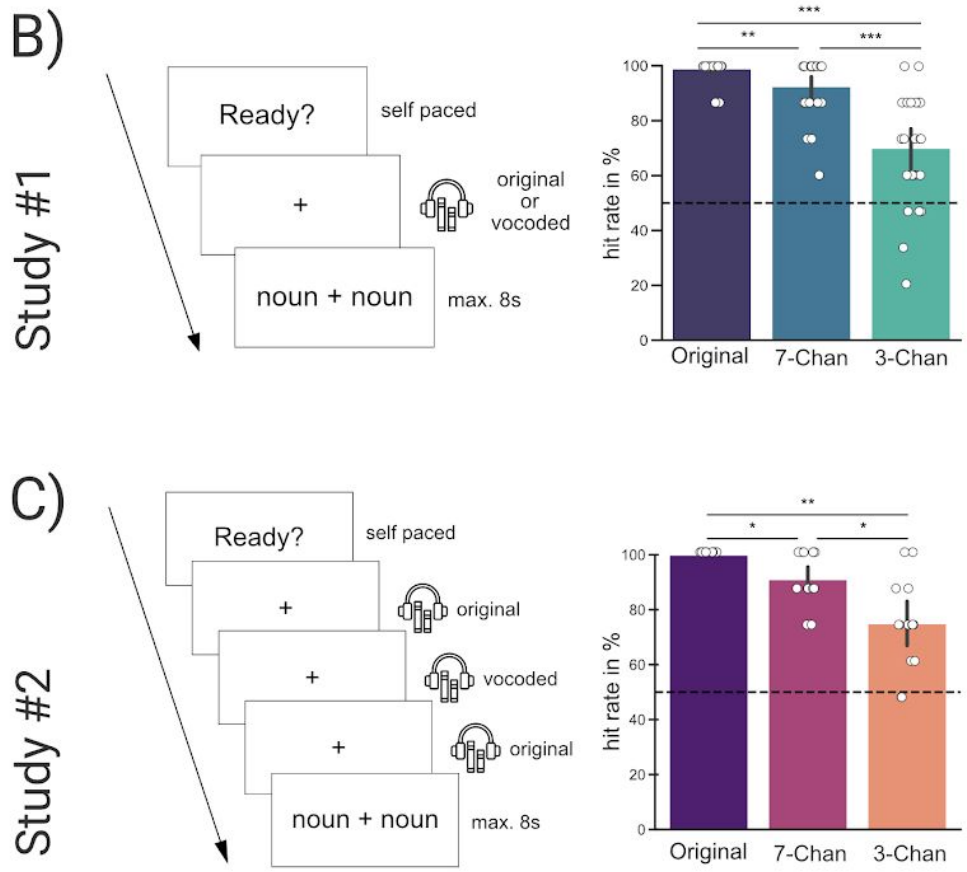
Speech comprehension decreases with intelligibility

3-Chan

7-Chan

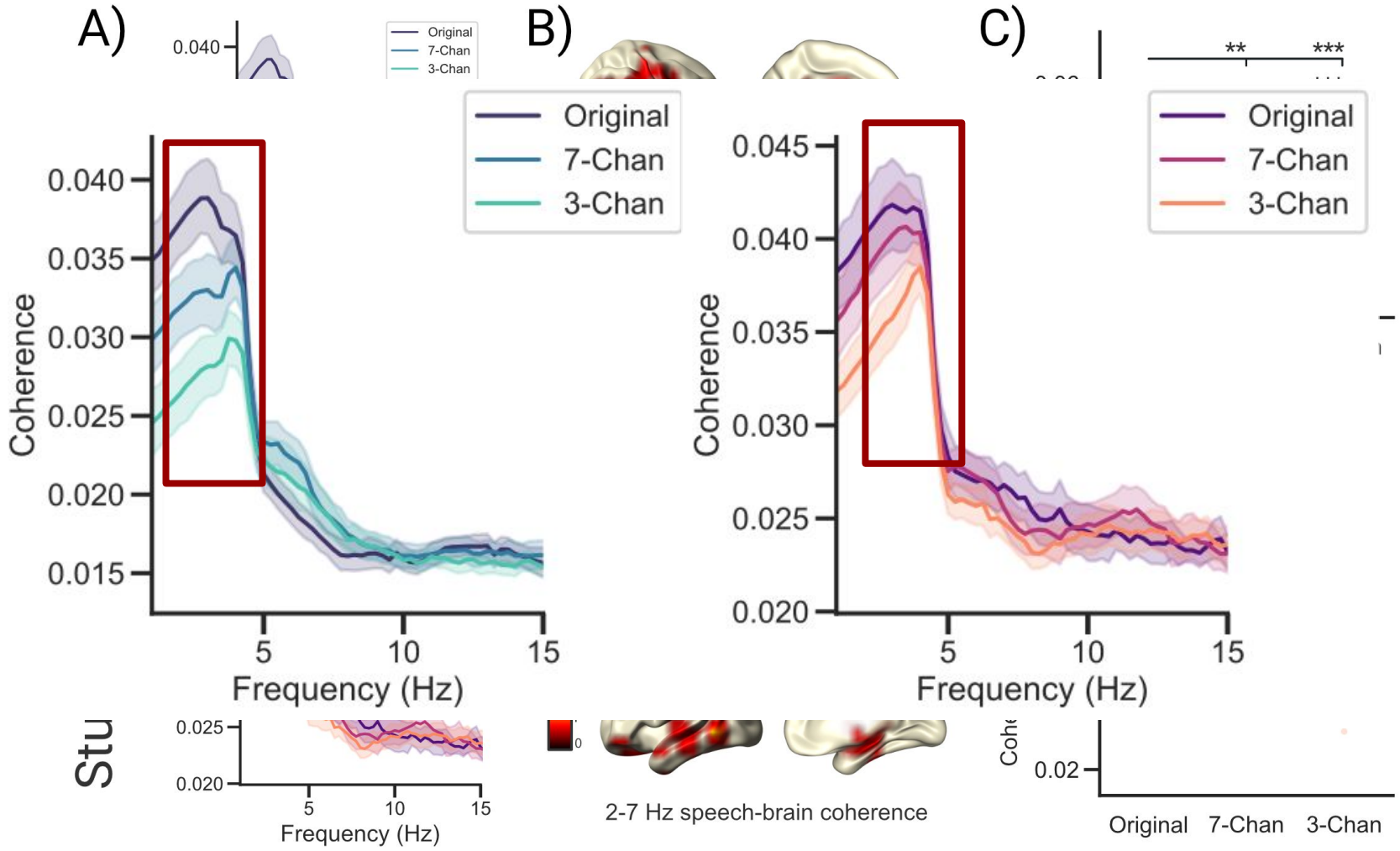
Original





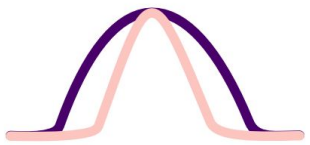
Schmidt et al., 2021

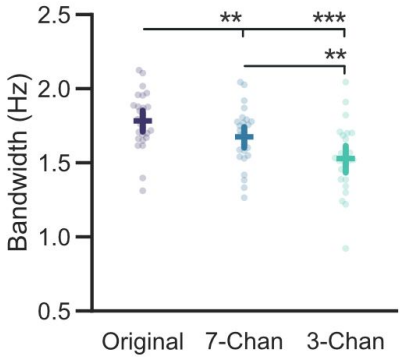
Broadband speech-brain coherence decreases with intelligibility

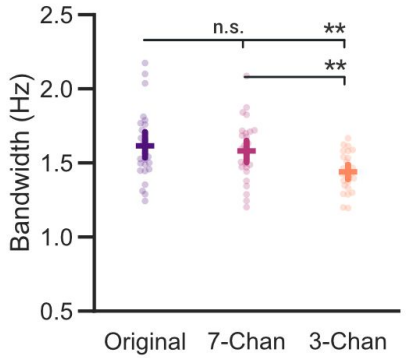


Schmidt et al., 2021

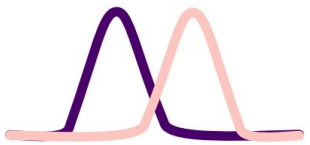
Bandwidth differences

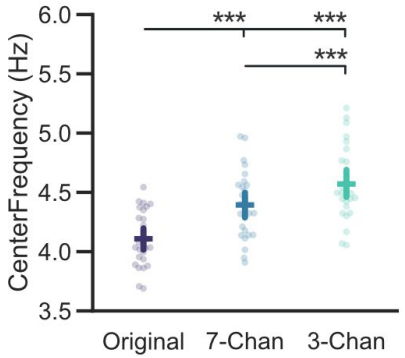


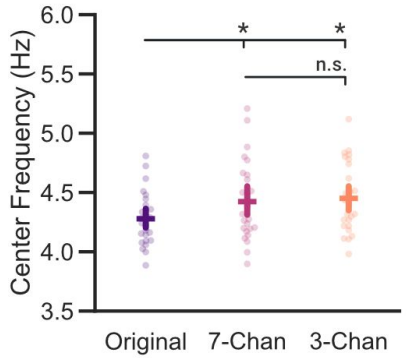




Center Frequency differences







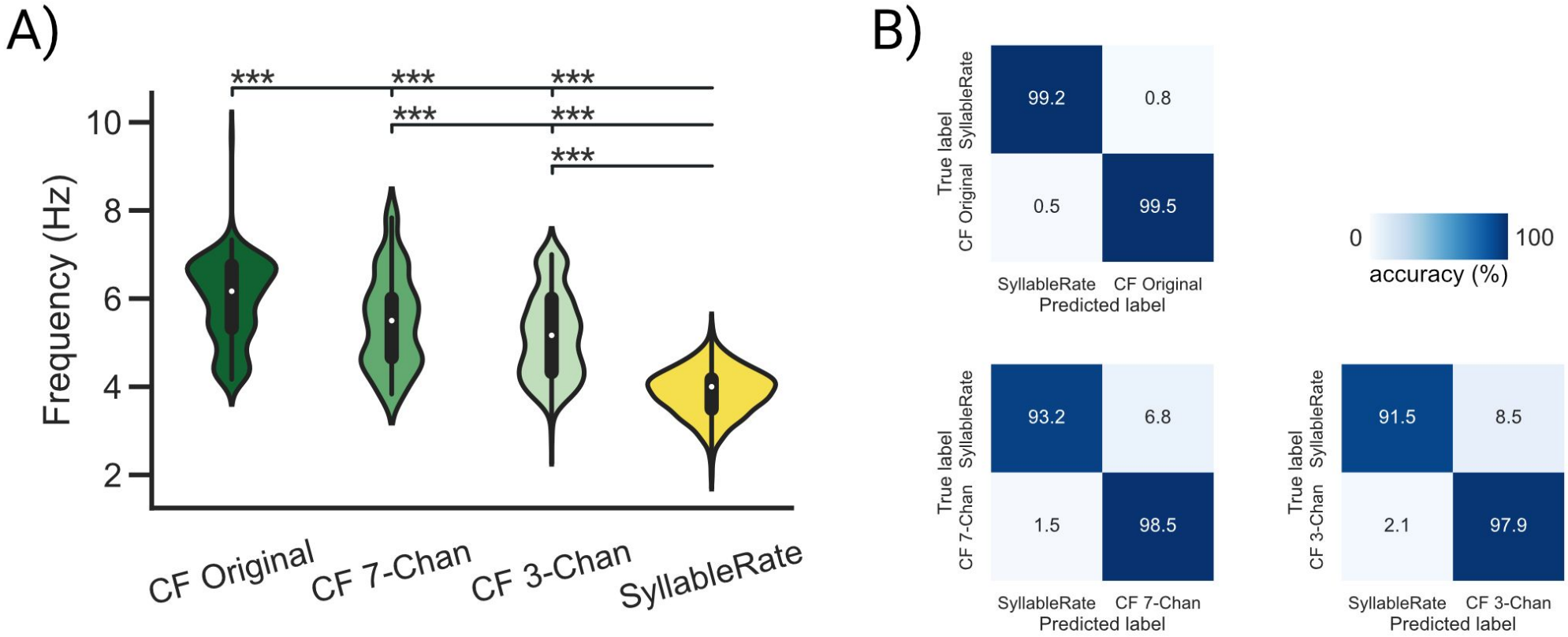
With declining speech intelligibility..

➔ the center frequency of speech brain coherence increases

➔ coherence peaks show a sharper tuning

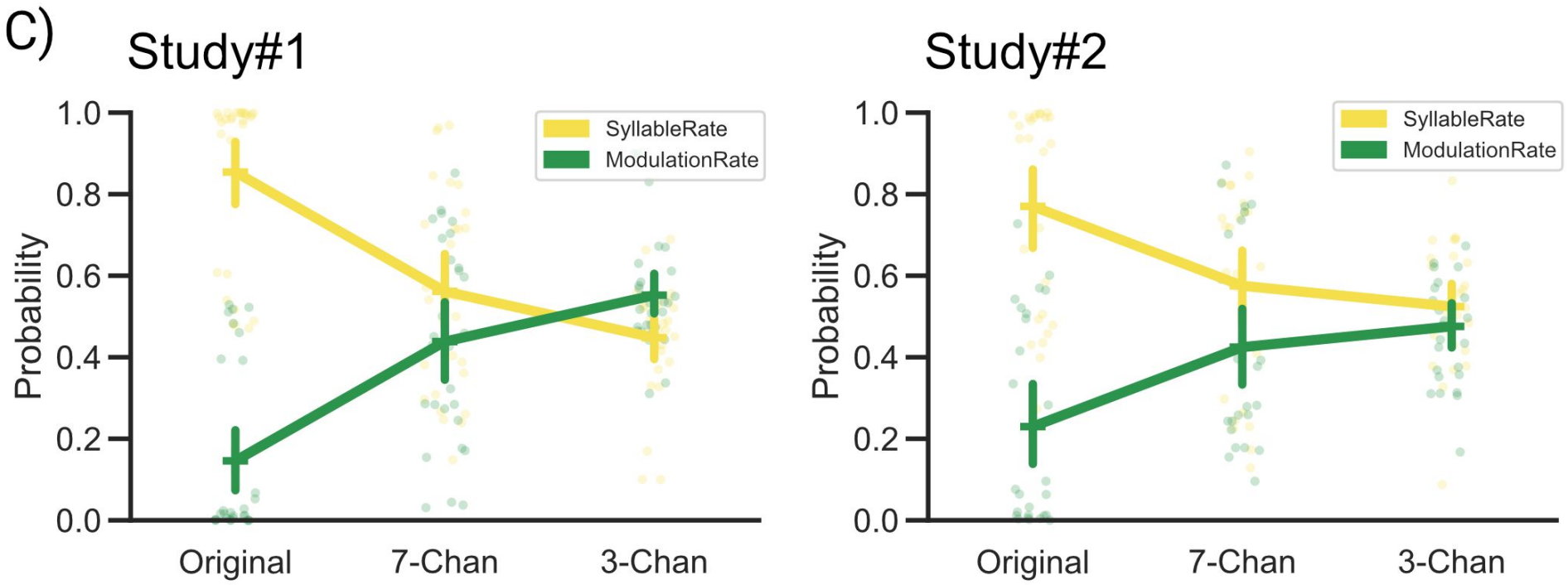
Schmidt et al., 2021

Spoken syllabic and modulation rates differ in our speech material



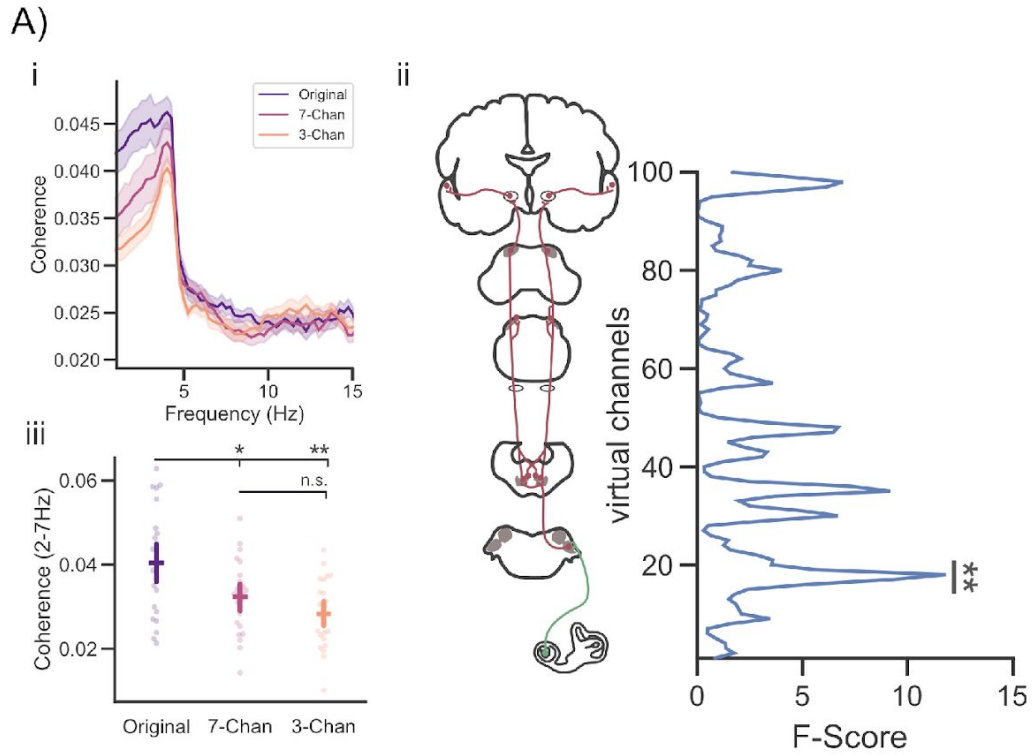
Schmidt et al., 2021

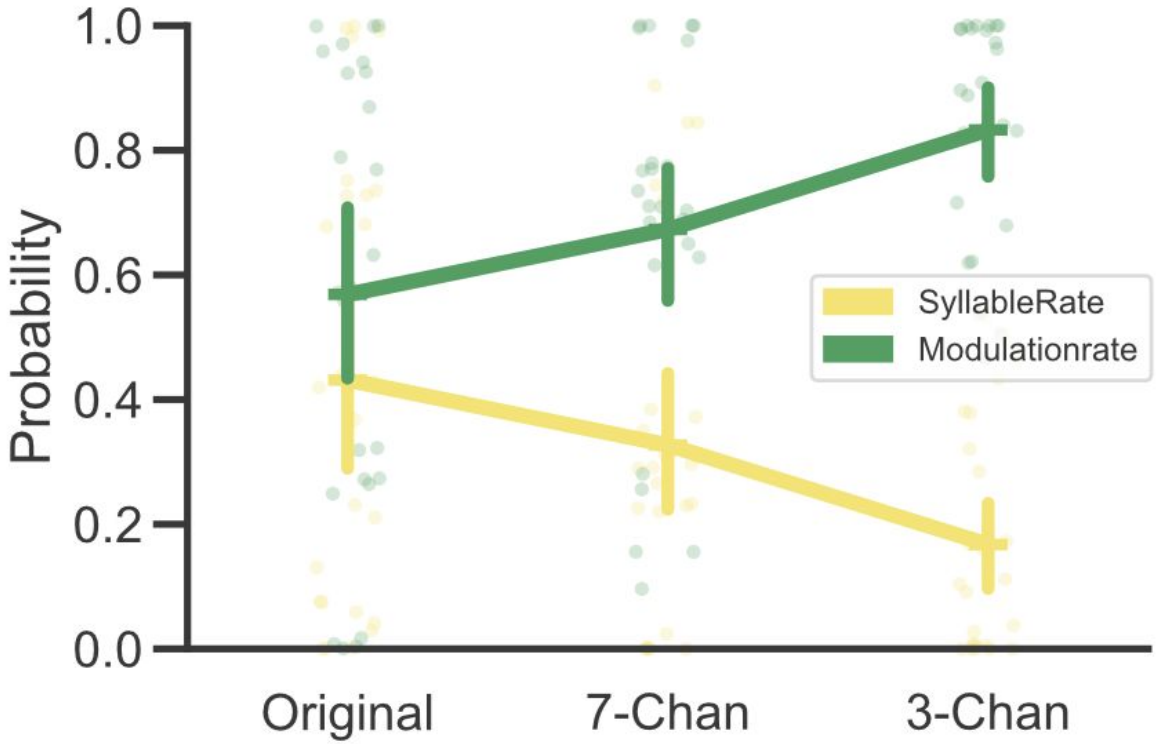
Cortical activity predominantly tracks the syllabic rate of speech



Schmidt et al., 2021 [10]

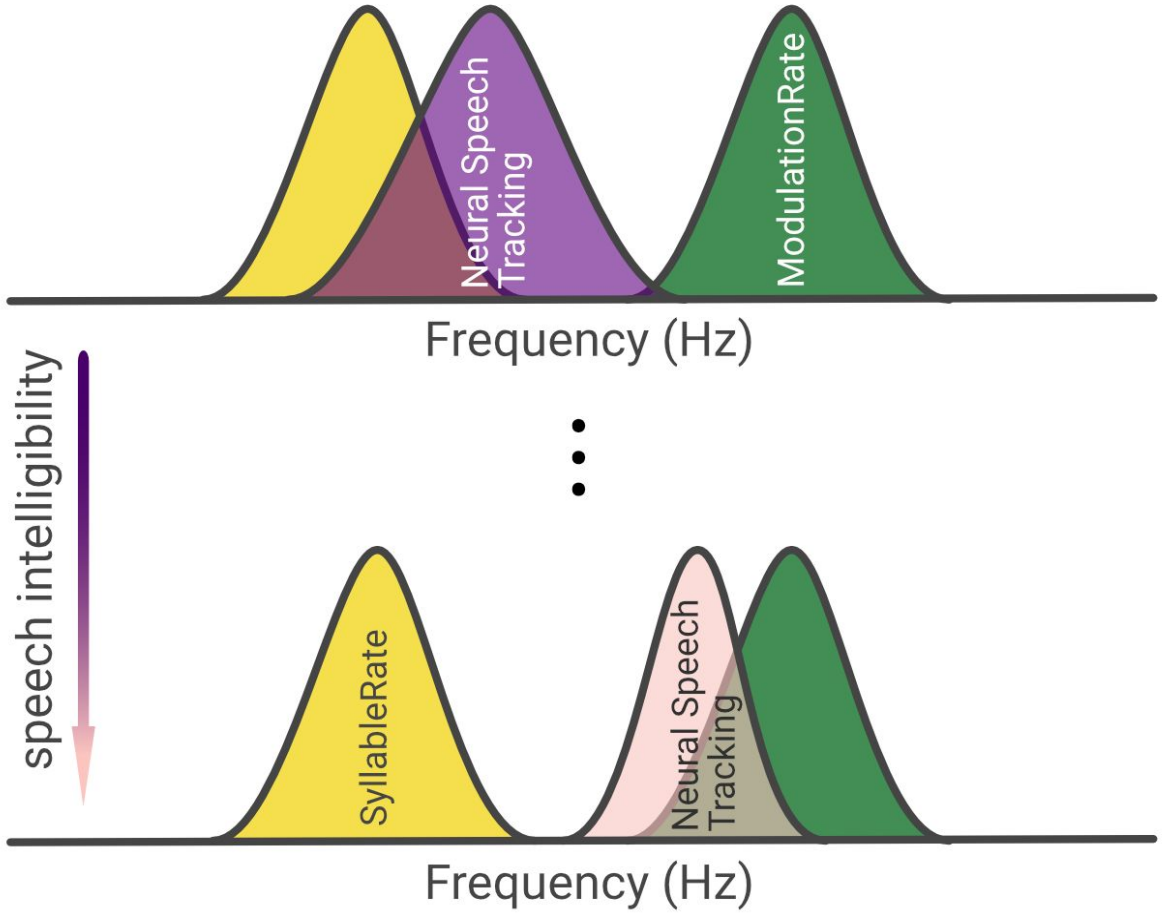
Subcortical auditory activity predominantly tracks the acoustic modulation rate of speech





Schmidt et al., 2021 [11]

Neural speech tracking shifts from the syllabic to the acoustic modulation rate as intelligibility decreases



Schmidt et al., 2021 [12]

Outlook & next steps

- separating auditory processing disorders (e.g. hearing loss) from language processing disorders (e.g. developmental dyslexia)

- looking at more complex acoustic and linguistic features

Acknowledgements

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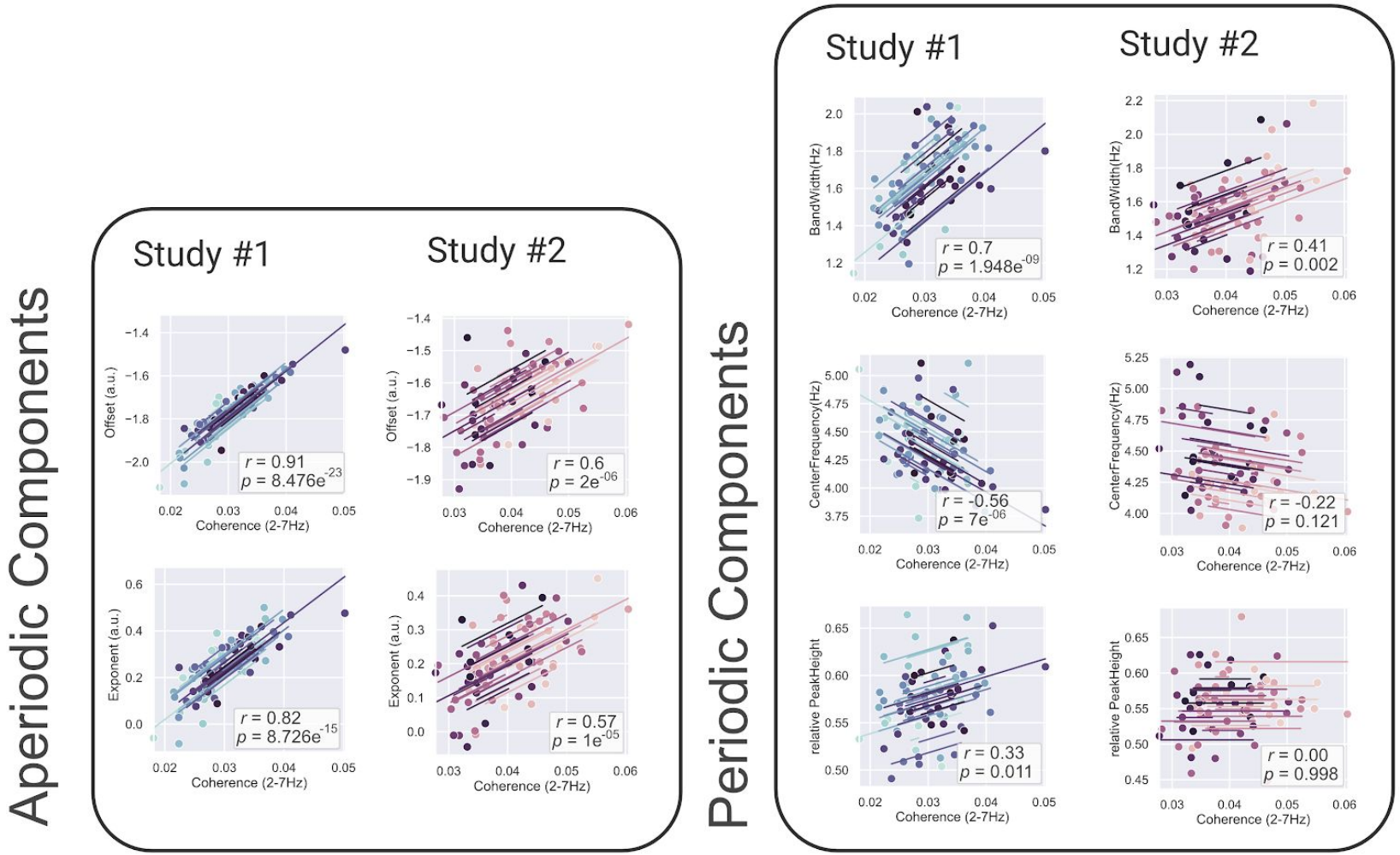
Centre for Cognitive Neuroscience

Additional Slides

Aperiodic components explain most of the variance of low frequency speech-brain coherence



Schmidt et al., 2021 [16]