EEG beta power during planning predicts motor sequence initiation time

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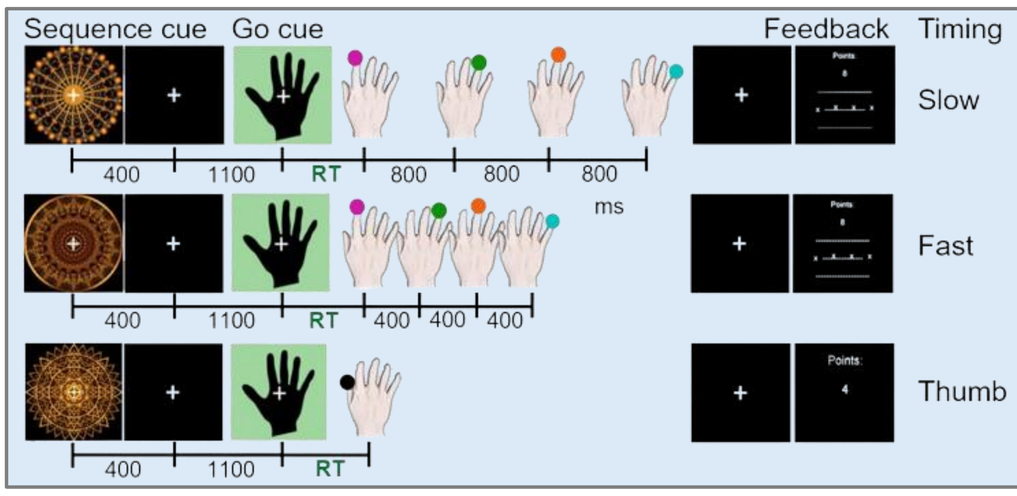
Background

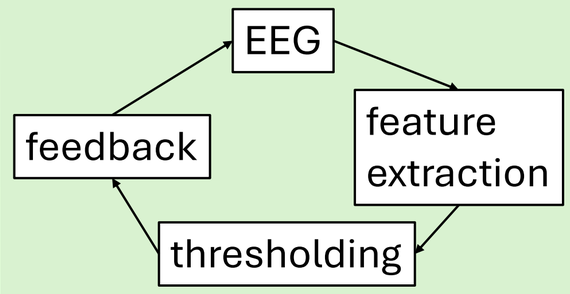
- Parkinson's Disease (PD) patients experience impaired movement sequence initiation and bradykinesia (He et al., 2020).
- In their electroencephalogram (EEG), beta band event-related desynchronization (ERD) is typically reduced during movement (Mehler, 2022).
- We investigate how ERD preceding movement onset (motor planning) is linked to subsequent motor performance to provide targets for brain-computer interface (BCI) neurofeedback.



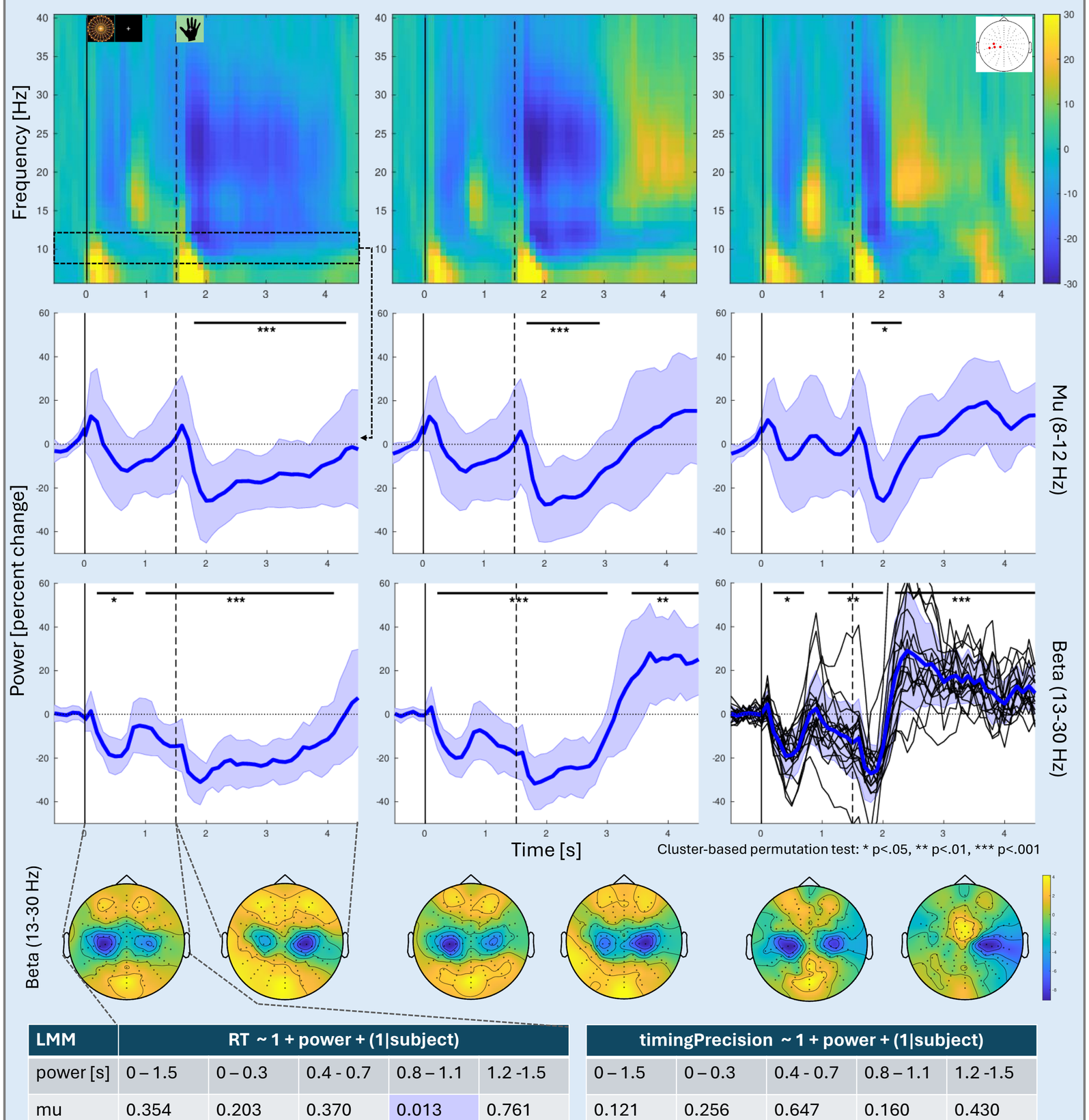
Finger sequence production task

19 healthy participants were trained to retrieve and produce from memory a four-finger press sequence with two different timings (slow or fast) or press a sequence-irrelevant control effector (thumb) on a computer keyboard after a 1500 ms planning period.

Neurofeedback BCI



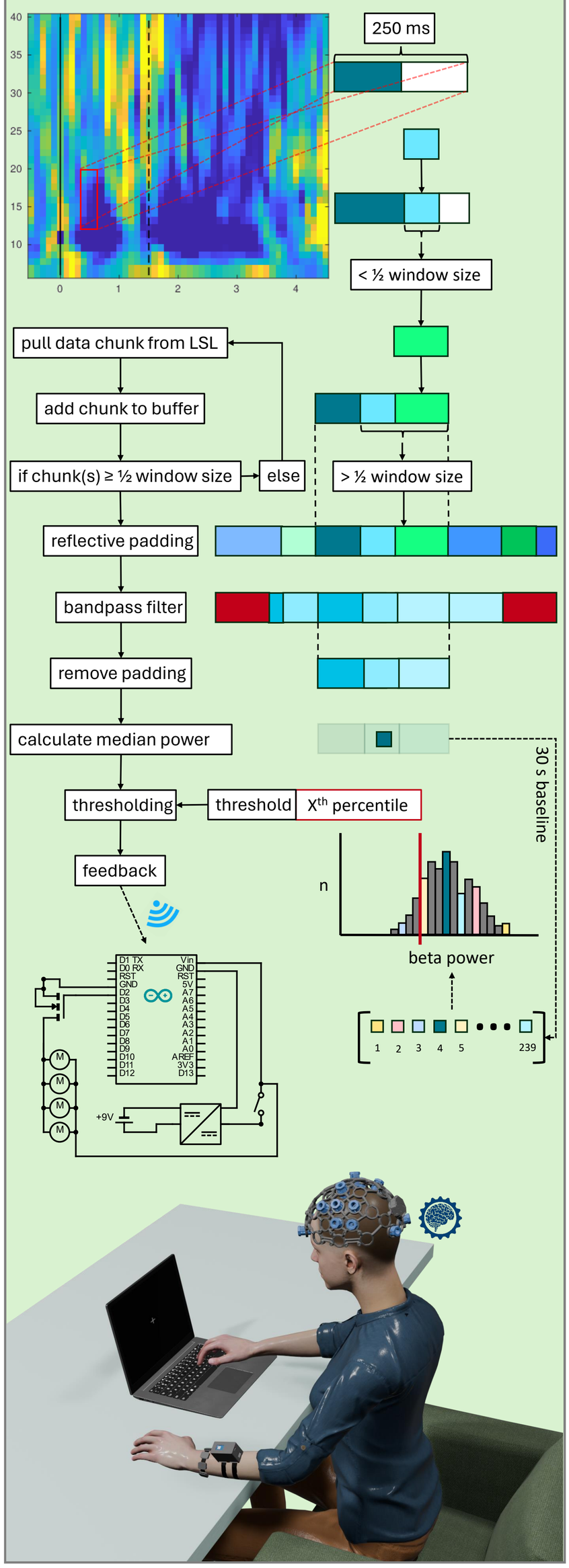
Slow | Fast | Thumb



LMM	RT ~ 1 + power + (1|subject)				
power [s]	0 – 1.5	0 – 0.3	0.4 - 0.7	0.8 – 1.1	1.2 -1.5
mu	0.354	0.203	0.370	0.013	0.761
lowBeta	0.066	0.588	0.007	0.021	0.992
highBeta	0.742	0.538	0.854	0.083	0.861
beta	0.246	0.501	0.150	0.022	0.984

timingPrecision ~ 1 + power + (1|subject)				
0 – 1.5	0 – 0.3	0.4 - 0.7	0.8 – 1.1	1.2 -1.5
0.121	0.256	0.647	0.160	0.430
0.010	0.248	0.131	0.037	0.160
<.001	0.061	0.040	0.007	0.027
<.001	0.082	0.030	0.004	0.029

Single trial



Conclusions

- Single-trial low beta power (13-20 Hz) is modulated during planning of motor sequence and significantly predicts behaviour

➔ We are implementing a neurofeedback BCI to train PD patients to voluntarily enhance beta ERD during planning to facilitate motor sequence execution.

References

He, S., Everest-Phillips, C., Clouter, A., Brown, P., & Tan, H. (2020). Neurofeedback-Linked Suppression of Cortical β Bursts Speeds Up Movement Initiation in Healthy Motor Control: A Double-Blind Sham-Controlled Study. *Journal of Neuroscience*, *40*(20), 4021–4032. https://doi.org/10.1523/JNEUROSCI.0208-20.2020

Mehler, D. M. A. (2022). Turning markers into targets – scoping neural circuits for motor neurofeedback training in Parkinson's disease. *Brain-Apparatus Communication: A Journal of Bacomics*, *1*(1), 1–27. https://doi.org/10.1080/27706710.2022.2061300