3D Dynamics of β Oscillation Phase in the Monkey Motor Cortex During a Reaching Task

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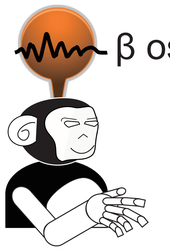
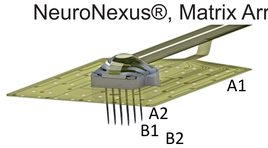
Purpose

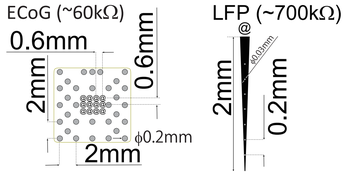


How can we relate spatiotemporal dynamics of β oscillation in the motor cortex to visuomotor events when monkey performs reaching movements ?

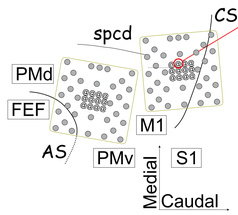
Experimental procedure

NeuroNexus®, Matrix Array™

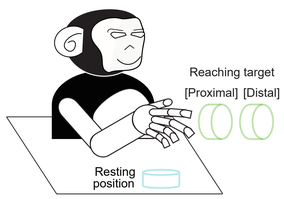




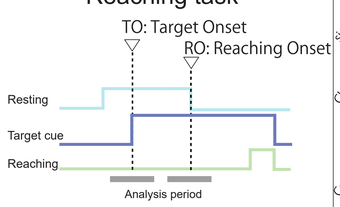
- Electrode locations in the motor cortex



Behavioral task



Reaching task



Chronic recording

Recorded signals from the electrodes were amplified, band-pass filtered between 0.3 and 7.5 kHz, and recorded digitally (16-bits) at 20 kHz per channel using a Cerebus™ Neural Signal Processor (Blackrock® Microsystems, LLC, UT, US) and SmartBox™ (NeuroNexus®, MI, US).

Percent phase-locking (PPL)

A measure of phase-locking computed across trials.

- Frequency analysis: One of three β oscillation bands, 14±2Hz, 22±2 Hz, 29±2 Hz, was bandpass filtered.
- Apply Hilbert transform to compute phase for each β oscillation band
- Divide phases over 2 π into 12 segmentations (*N*=12)

$$PPL(i,t)=100(1-H(\varphi(i,t)))/H_{max}$$

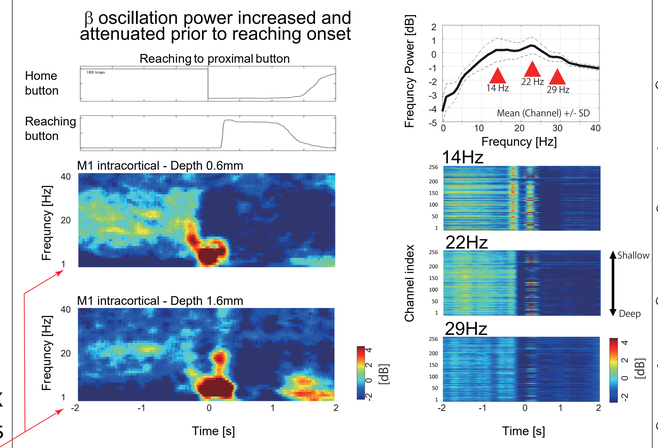
$$H(\varphi(i,t))=-\sum p_k \log_2 p_k$$

$$H_{max}=\log_2 N$$

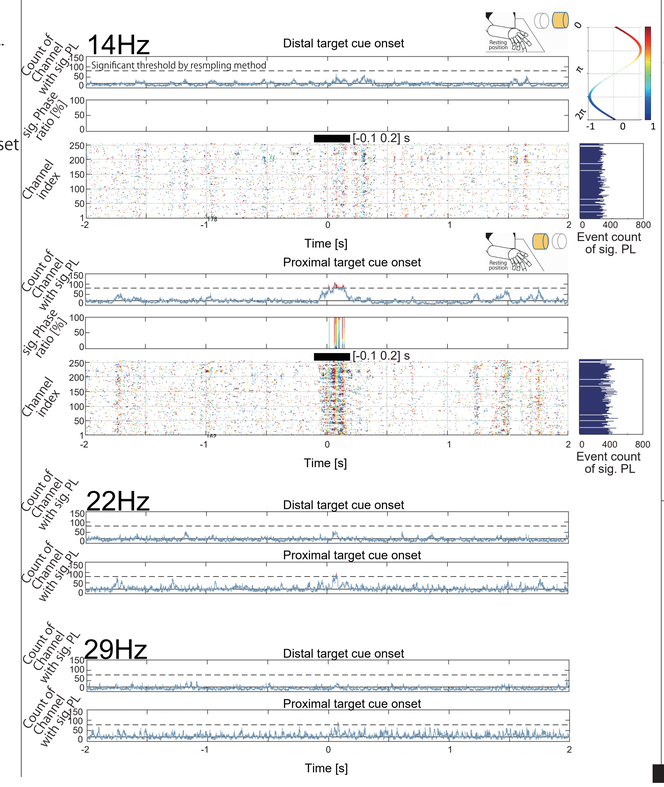
Application of resampling method to assess significance of PPL at a given time

Spectrogram around reaching onsets

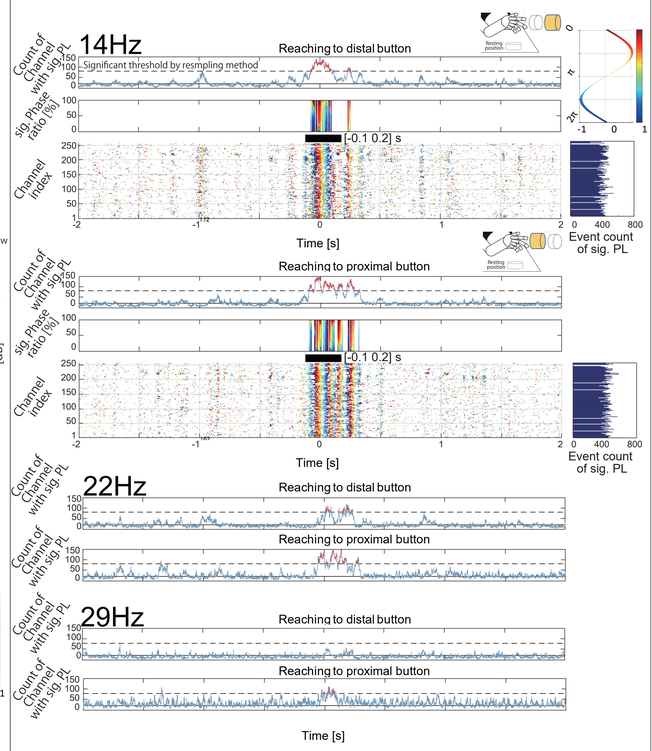
β oscillation power increased and attenuated prior to reaching onset



Task dependent clustering of β phase locking around cue onsets

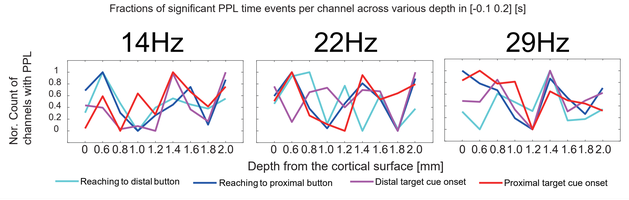


β phase locking appeared around reaching onsets

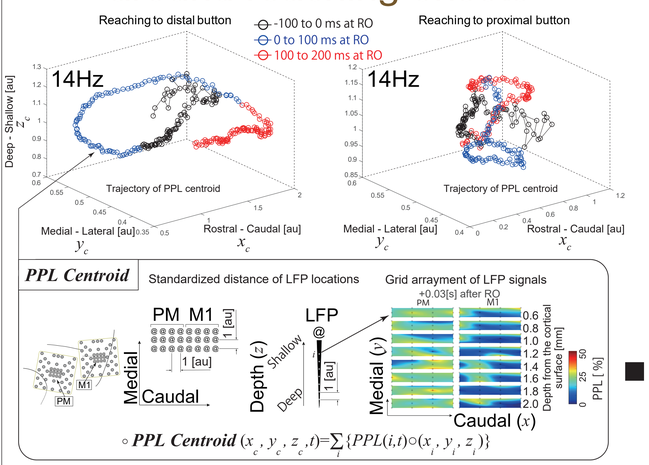


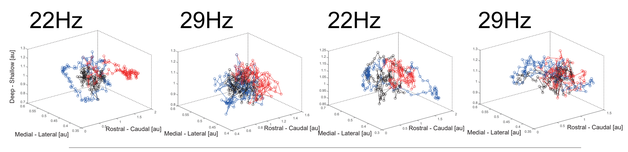
Non-systematic distribution of channels with phase locking in various depth around reaching onset and cue onsets

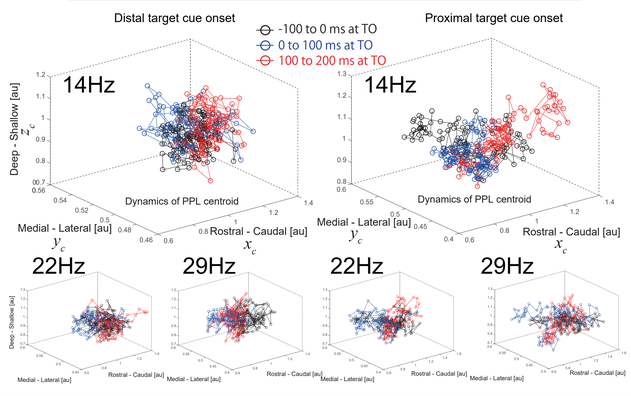
Fractions of significant PPL time events per channel across various depth in [-0.1 0.2] [s]



Dymamic depth modulation of occurrences of phase locking at multiple β bands around reaching onsets







Conclusion

- The PPL in many channels after TOs showed modulation on instructions of an upcoming movement.
- There was a transient progression in peak PPL timing of each channel locked to ROs in contrast to those after TOs.
- Uniform distribution of PPL across various depth of LFPs in the motor cortices around RO and TO.
- Modulation of phase locking of low β band (~14Hz) exhibits both horizontal and depth dynamics around RO in the motor cotex.
- These results indicate that phase of β oscillation in the motor cortex may carry task relevant information contained in cue signals and about reaching.

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