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Presentation Abstract

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Presentation Title: Signal selection and conditioning for human ECoG driven brain machine interfaces

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Abstract: Brain machine interfaces (BMIs) may provide partial functional restoration for paralyzed individuals and amputees by translating neural signals into intended user actions. A number of neural signal acquisition methods exist; subdural electrocorticography (ECoG) has been demonstrated previously as a potential BMI signal source.
To study the potential for ECoG driven BMIs, we recorded neural signals simultaneously with contralateral finger flexion during real and imagined hand movements (Blabe et al., SFN 2011), including single finger flexion, fist, splay, pinch, and point. Neural signals were recorded from implanted ECoG grids and strips, with coverage including primary motor, premotor, supplementary motor, and primary sensory cortex.
Signal fidelity is reduced by many electrical noise sources present in the clinical setting. Thus, care was taken to identify an effective referencing scheme. 60 Hz and 120 Hz noise were virtually undetectable after common average referencing with restricted channel sets. We restricted analysis to non-railing channels and grouped channels with consistent 60 Hz noise characteristics. This criteria retained 62 of 64 recorded channels.
Data were analyzed to identify frequency and temporal bands of interest. In

general, high gamma band (72 Hz-244 Hz) power increased and beta band (13-35 Hz) power decreased during movement. Power was calculated in 100 ms bins 1000 ms before and after movement onset. Across movement types, significant ($p < 0.001$, Bonferroni corrected) high gamma activation was present relative to baseline on 58 channels. Significant beta suppression was present on 44 channels. The time course of these band modulations varied from channel to channel.
To better understand this variation, electrodes were localized using pre-surgical MR and post-surgical CT imaging. High gamma activation preceded movement onset by 800 ms on a subset of motor electrodes and spread to all modulated motor and sensory electrodes within 400 ms. Significant motor activation diminished between 300-600 ms after movement onset, followed by deactivation in sensory areas, with no significant activation 1500 ms after movement onset. Beta band suppression followed a similar spatial pattern and started around 600 ms before movement onset. However, the duration was longer, with significant deactivation up to 2000 ms after movement onset.
These findings support the use of high gamma band power from human ECoG as an input to a BMI as is implemented offline by Chestek et al. (SFN 2011). The results also suggest that a detailed understanding of activation time course and spatial dependencies may be critical for optimizing system performance.

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