# Beta and Low Gamma Cortical Waves during different states of motion in 6-OHDA hemi-parkinsonian rats

Christian A. Polar, Rahul Gupta, Mark J. Lehmkhule, Alan D. Dorval

CORTICAL beta waves (20-40 Hz) with a pathological increase of power have been linked to Parkinson's disease in humans and animals [1]. Moreover, studies in healthy humans have shown that power spectral peaks in beta and low gamma (40-70 Hz) power do not occur simultaneously, but when the power of one frequency range increases, the power in the other range decreases [2]. This may suggest that the same mechanism is recruited by both types of waves. In this study we investigate the relation of cortical beta and low gamma waves in freely moving rats before and after injections of 6-OHDA.

## I. Methods

This study was done on free moving Long Evans rats. The position of the animals and ECoG data were recorded simultaneously, allowing us to study the changes in power of cortical waves at different speeds of the animal. After 30 hours of recordings from healthy animals, 6-OHDA was injected into the right forebrain medial bundle through an implanted cannula. The animals were allowed to recover for 2-3 weeks after the injections before recordings were reinitiated. Deep brain stimulation was delivered through a concentric bipolar electrode targeting the subthalamic nucleus. Four different settings of stimulation were used with 150 Hz and 250 Hz frequency and 90% and 60% of the stimulation amplitude threshold for dyskinetic muscle contraction.

## II. Results

Power spectral density plots show that power in the beta and gamma ranges change opposite to each other as a function of the animal's speed. Specifically, cortical beta power is larger at rest than at motion and the same but opposite is true for gamma power. After 6-OHDA injections, a distinct power bump centered at about 30 Hz can be observed for all animals. The peak of the bump shifts towards higher frequencies when the rat is in motion relative to at rest. However, the power in the ~30 Hz bump either stays the same, or increases during movement. In contrast, the power between 15 and 25 Hz always decreases with movement onset, and the power between 35 and 50 Hz always increases. Moreover, when comparing accelerating and decelerating states for the same speed range, we observe that deceleration decreases gamma while it increases beta. Furthermore, for a parkinsonian rat, decelerating decreases the amplitude of the power bump, an effect that is more dramatic when moving at slow speeds.

## III. Discussion

Cortical Beta and Gamma waves appear to act together but opposite to each other when a rat transitions from motion to rest and vice-versa. When a rat is parkinsonian, however, it develops a pathological increase in power centered at around ~30 Hz, in the transition range between beta and gamma frequencies. Contrary to power in the beta range, the pathological peak's amplitude is reduced with deceleration. Faster speeds, on the other hand, shift the peak towards higher frequencies but do not show a consistent effect on the amplitude of the peak. All together, these results may suggest that the pathological increase in power could be caused in part by the same mechanism responsible for generating waves in the low gamma range.

## References

[1] Hutchison et al. "Neuronal Oscillations in the Basal Ganglia and Movement Disorders: Evidence from Whole Animal and Human Recordings," The Journal of Neuroscience, October 20, 2004, 24(42), pp 9240 –9243.

[2] Alexa Riehle and Eilon Vaadia, eds. *Motor Cortex in Voluntary Movements: A Distributed System for Distributed Functions.* Boca Raton: CRC 2004, pp 210-243

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C. A. Polar is with the Biomedical Engineer Department, University of Utah, Salt Lake City, UT 84112 USA (phone: 208-860-6704; fax: (801) 585-5361; e-mail: christian.polar@utah.edu).

R. Gupta is with Global Research, Medtronic Neuromodulation, Minneapolis, MN 55432 USA, (email: rahul.gupta5@medtronic.com).

M. J. Lehmkuhle is with the University of Utah, Salt Lake City, UT 84112 USA, (email: mark.lehmkuhle@utah.edu).

A. D. Dorval. is with the Biomedical Engineering Department, University of Utah, Salt Lake City, UT 84112 USA (e-mail: chuck.dorval@utah.edu).