

Broadband shifts in EEG power spectra are correlated with single-neuron activity in humans

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1 Introduction

- We studied the relationship between the EEG power spectrum and the firing rates (FR) of individual neurons in the human brain
- Other researchers^{1,2} have reported high correlations between the power of high frequency (γ) oscillations and FR
- We developed a statistical framework to distinguish between broadband shifts in the EEG power spectrum³ and band-specific peaks
- We also examined the correlation between FR and EEG power at narrow frequency bands, including γ

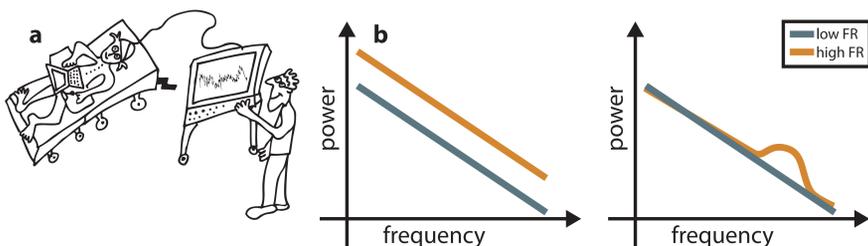


Figure 1. a. Experimental setup. b. Two possible relationships between the EEG power spectrum and FR

2 Methods

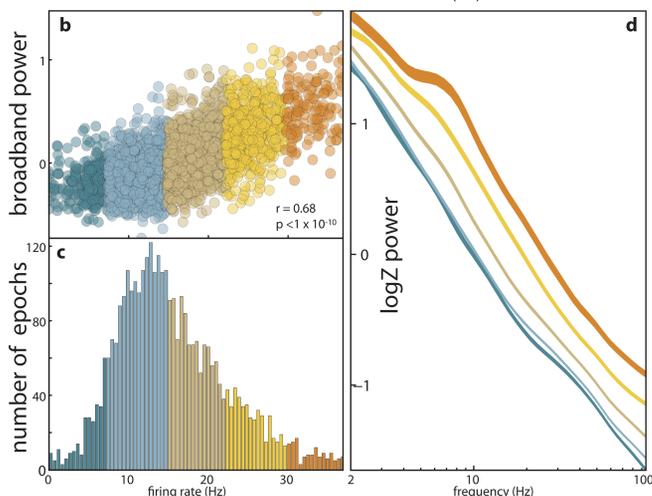
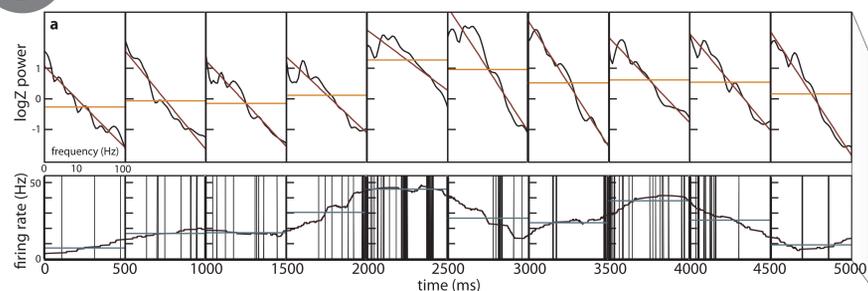
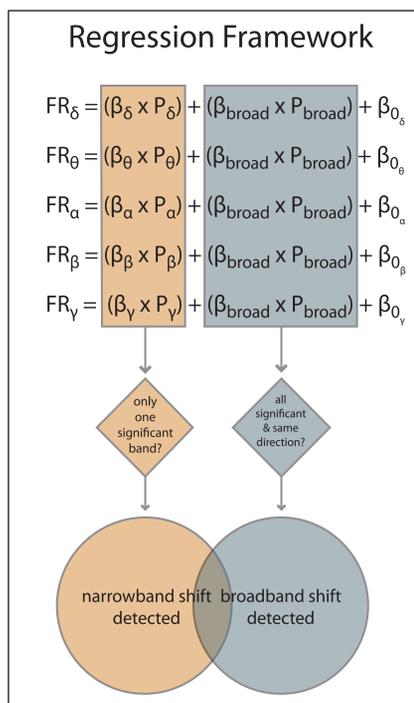


Figure 2. a. We divide each cell's recording session into 500 ms epochs. b.-d. We study the epoch-by-epoch relationship between the EEG power spectrum and FR

3 Results



a Predicted Results

	No Relationship broadband shifts			Positive Narrowband			Positive Broadband		
narrowband shifts	-/+	0/+	+/+	-/+	0/+	+/+	-/+	0/+	+/+
	-/0	0/0	+/0	-/0	0/0	+/0	-/0	0/0	+/0
	-/-	0/-	+/-	-/-	0/-	+/-	-/-	0/-	+/-

b Actual Results

<1%	12%	5%
<1%	58%	22%
<1%	2%	<1%

Figure 3. a. Results predicted given assumed relationships between EEG and FR. b. We find evidence for both narrowband and broadband shifts. Broadband shifts are more common.

Narrowband Shifts

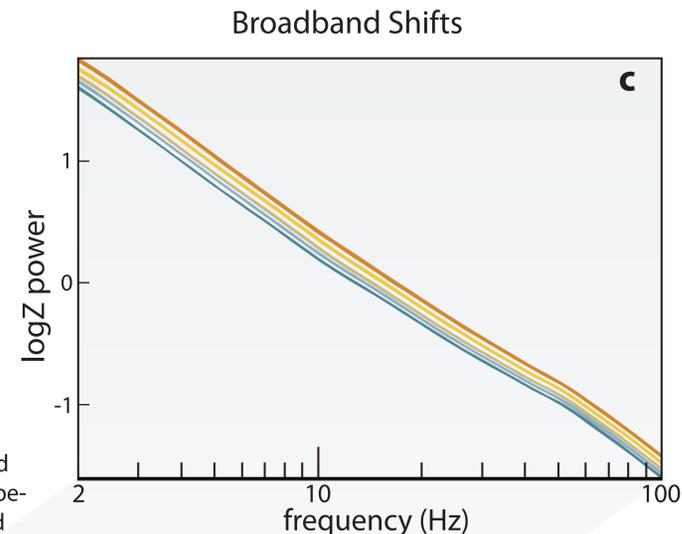
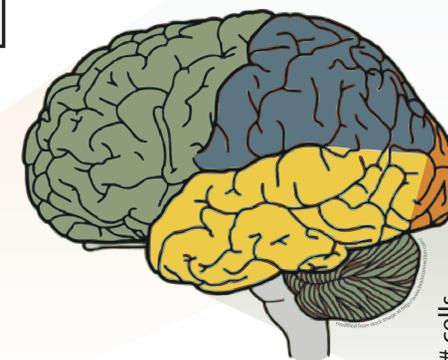
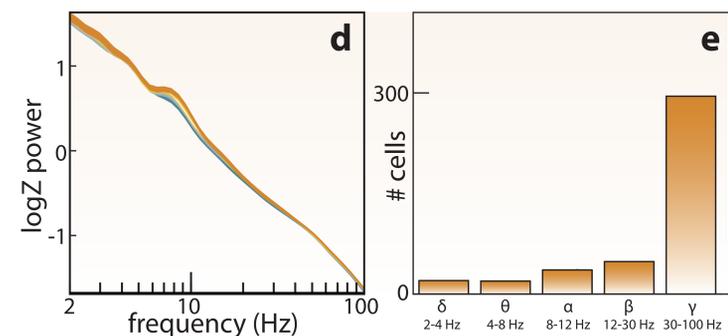
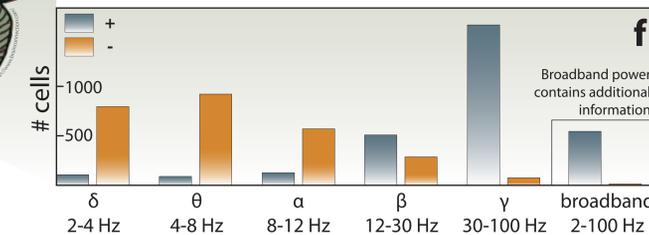


Figure 4. c. Power spectrum averaged across all 439 cells exhibiting pure positive broadband shifts. d. Example cell showing a pure narrowband shift in the α band. e. Across the 241 cells which exhibited pure positive narrowband shifts, most shifts occurred in the γ band. f. Across the entire population of 2,030 cells, which power-spectrum features were correlated with FR?

EEG correlates of FR



4 Conclusions

- In agreement with the literature, we found both narrow band and broadband effects
- More cells show broadband shifts than narrowband shifts
- Broadband power contains information about FR not contained in any individual frequency band

5 Bibliography

1. Mukamel, R., Gelbard, H., Arieli, A., Hasson, U., Fried, I., and Malach, R. 2005. Coupling between neuronal firing, field potentials, and fMRI in human auditory cortex. *Science*. 309: 951 - 954.
2. Belitski, A., Gretton, A., Cesare, M., Marayama, Y., Montemurro, M. A., Logothetis, N. K., and Panzeri, S. 2008. Low-frequency local field potentials and spikes in primary visual cortex convey independent visual information. *The Journal of Neuroscience*. 28(22): 5696 - 5709.
3. Miller, K. J., Leuthardt, E. C., Schalk, G., Rao, R. P. N., Anderson, N. R., Moran, D. W., Miller, J. W., and Ojemann, J. G. 2007. Spectral changes in cortical surface potentials during motor movement. *The Journal of Neuroscience*. 27(9): 2424 - 2432.

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