**For Introduction**

Pushing by the necessity of a fast unbiased method for detection of SWRs in long recordings we adopted an automatic detection algorithm.

**For Methods**

**Automatic SPW detection**

To detect SPW times we first selected the channel with maximum variance, downsampled the data to 3000 sample per second, and band-pass filtered it in 1-100 Hz. Then to highlight fast large-amplitude events in the signal we passed it through Nonlinear Energy Operator (NEO) and finally followed an unsupervised threshold-crossing. NEO has been vastly used for detection of fast events specially spikes [1]. For a data sample x(n), the operator is defined as:

(eq. 1)

The NEO climaxes when the signal has a high amplitude (i.e., large ) as well as high frequency (i.e., is greater than its neighboring points, and ). Visual inspection of typical SPWs shows that their duration is in order of hundreds of milliseconds. So, instead of 1 sample of time shift in ***eq. 1*** we considered 125 ms adjacent points (±375 neighboring samples) to subtract from . As the histogram of NEO output values, in ***Fig. 1 X***, shows, majority of values are concentrated around zero, implying baseline activity being suppressed by NEO, and there is a long narrow positive tail, indicating magnification of SPWs. In order to have a threshold to identify SPWs, we have to determine the variation range of baseline activity, i.e. the LFP wave without SPWs. So we set the threshold as 5 times the interquartile range of NEO outputs above its median value:

(eq. 2)

Where is the band-passed signal. Both interquartile and median are robust statistics to outliers so they essentially extract the baseline activity part of signal. Note that using mean and standard deviation leads to overestimation of threshold.



**Histogram of TEO values**

Fig. 1 x

**References**

Mukhopadhyay, Sudipta, and G. C. Ray. "A new interpretation of nonlinear energy operator and its efficacy in spike detection." *IEEE Transactions on biomedical engineering* 45.2 (1998): 180-187.