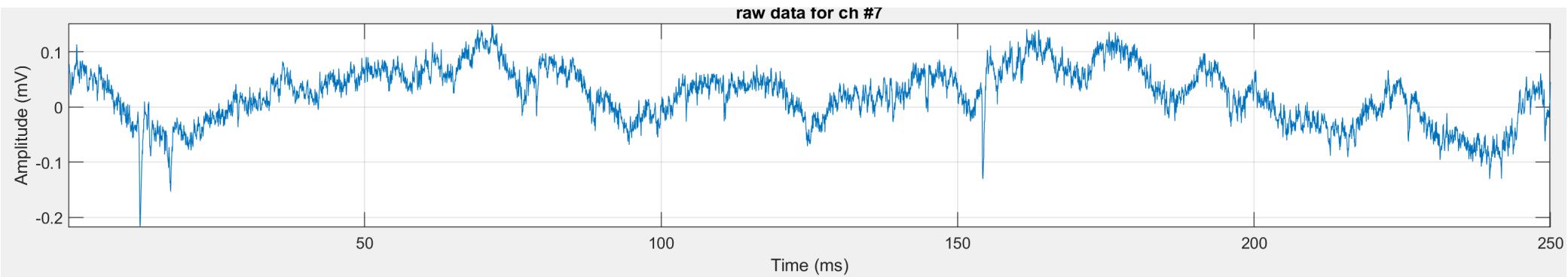


BIOE2615 – HW4

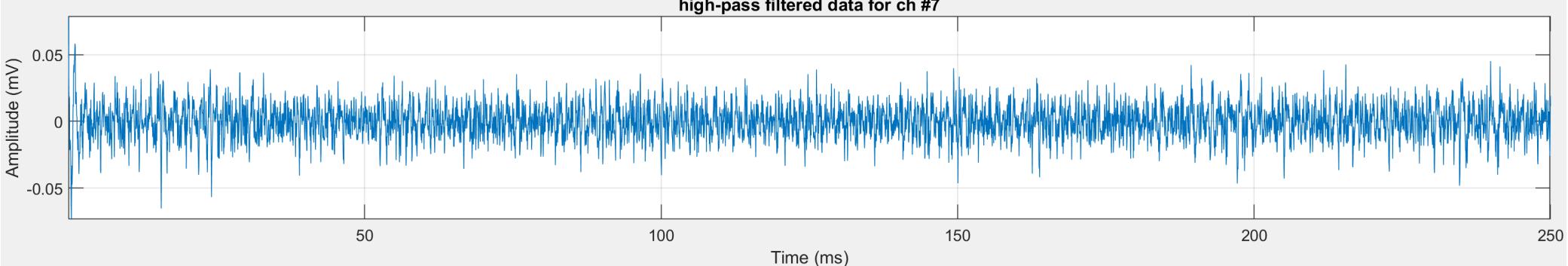
Arjan Singh Puniani

4527572 | arp150

a)



b)



c)

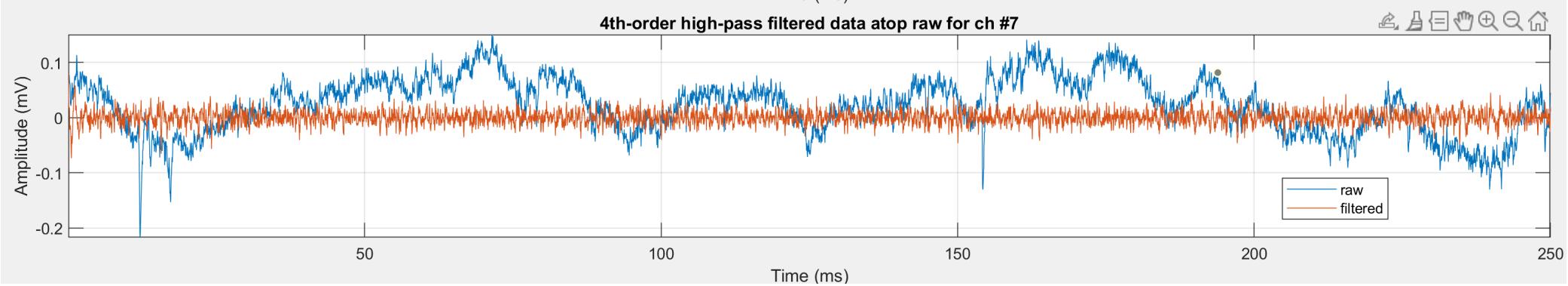


Figure 1.a: The first 250 ms of raw data from channel 7 is plotted in a). A 4th-order high-pass Butterworth with a 500 Hz cutoff frequency was applied to that raw data [in b)] to filter out low-frequency potentials and keep spikes, or action potentials. A lack of large spikes in the filtered data where we would expect spiking activity based on what the raw data looks like surprised me. For example, in c), it seemed as if the raw data's major spikes at ~13 ms and ~155 ms were not as prominent in the filtered waveform. A 4th order filter was selected to strike a balance between minimizing ripples and maximizing descent to the stop pass frequencies.

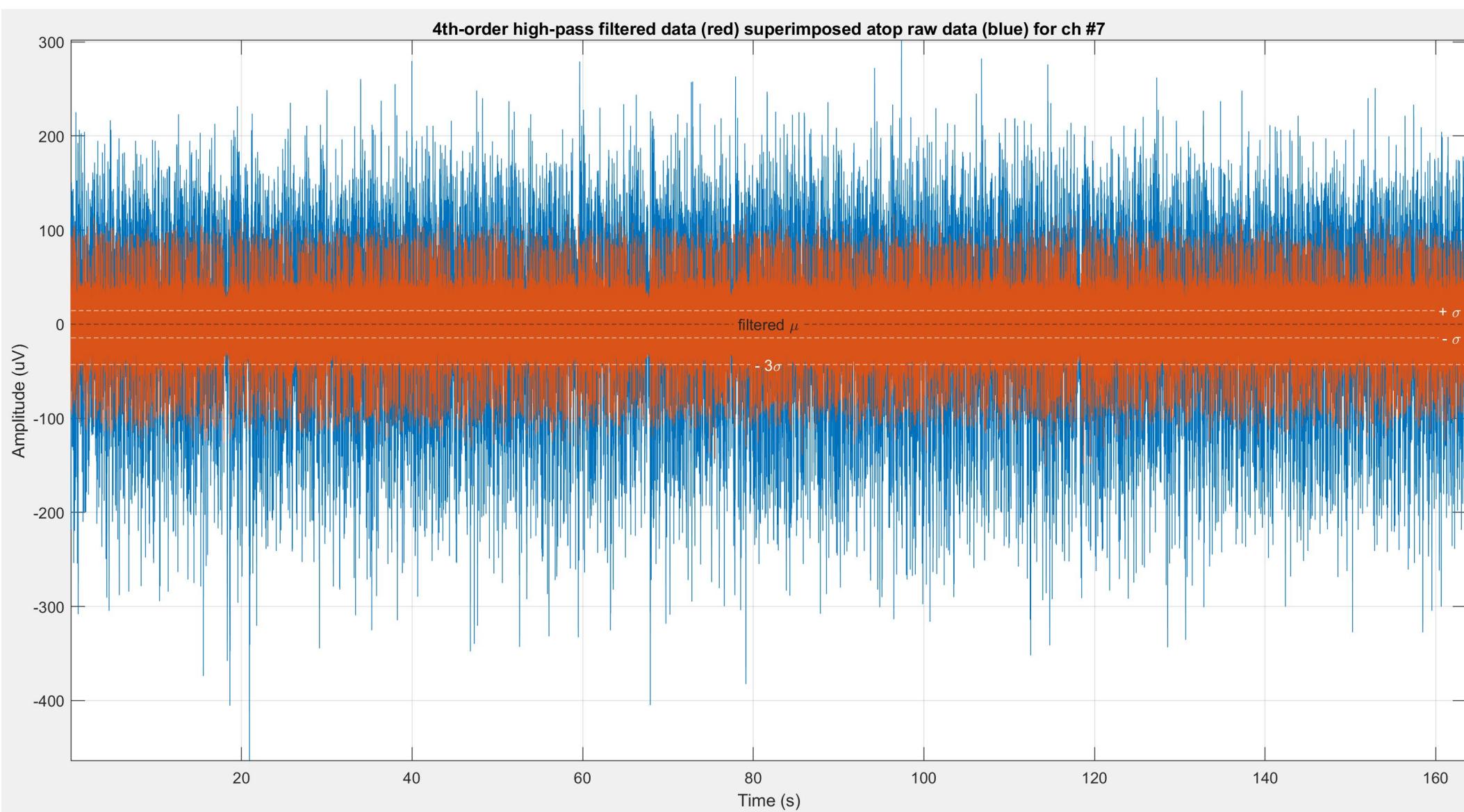


Figure 1.b: To help determine what kind of threshold to use, the entire dataset sampled for channel #7 was plotted (raw data in blue). The filtered data (red) was plotted over the raw data set, and the mean of the filtered data was found to be **14.7 nanovolts**. The standard deviation of the filtered data was **14.36 uV**. Three standard deviations below the filtered data appeared like a promising threshold candidate, since the level doesn't ostensibly permit many false positives from noise.

```

63- n_stimulations = numel(TrigON);
64- stim_time = mean(diff(TrigON));
65- new_indeces=[1:round(samprate*stim_time)]-round(0.5*samprate); % since the samprate tells us how many samples/sec
66- psth_dt = 0.05; % 50 msec bin
67- stim_duration = max(TrigOFF-TrigON);
68- time_psth = [-0.5:psth_dt:stim_duration];
69- t=([0:length(new_indeces)-1]/samprate)+time_psth(1);
70- %% HW way
71- figure
72- for ch=1:channels
73-     newdata=zeros(numel(new_indeces),numel(TrigON));
74-     for m=1:n_stimulations
75-         stimlocHW=find(tVec>TrigON(m),1);
76-         newdata(:,m)=data(stimlocHW + new_indeces,ch);
77-     end
78-     std_mult = 3.3;
79-     rasterHW=zeros(size(newdata));
80-     for m=1:n_stimulations
81-         threshold=(mean(newdata(:,m))-std_mult*(std(newdata(:,m))));
82-         ii=find(newdata(:,m)<threshold);
83-         idHW=find(diff(ii)>1);
84-         ii=[ii(1);ii(idHW+1)];
85-         rasterHW(ii,m)=1;
86-     end
87-     subplot(sqrt(channels),sqrt(channels),ch)
88-     plot_raster(t,rasterHW(:,1:12:60)), title("ch #" + ch)
89- end

```

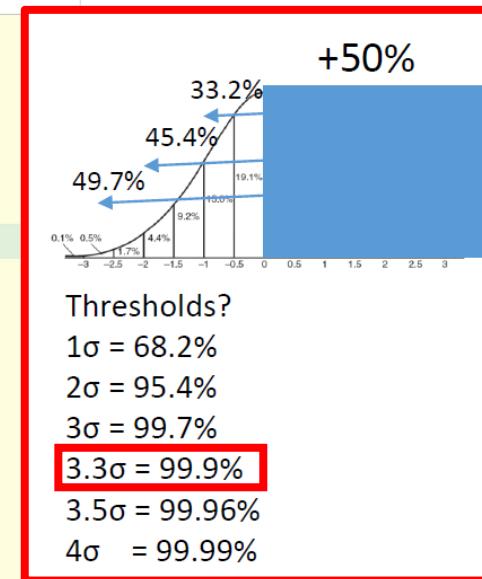
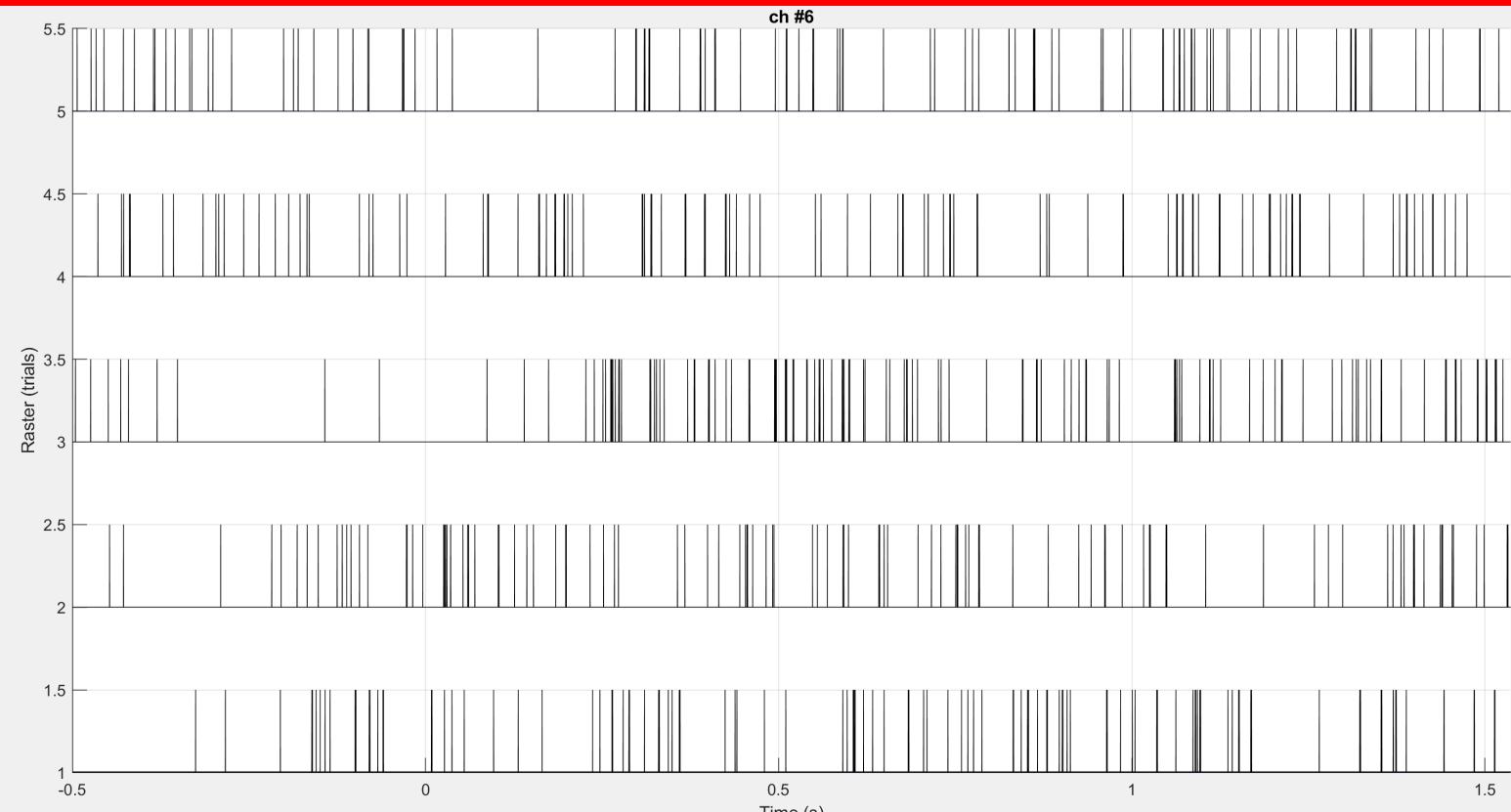
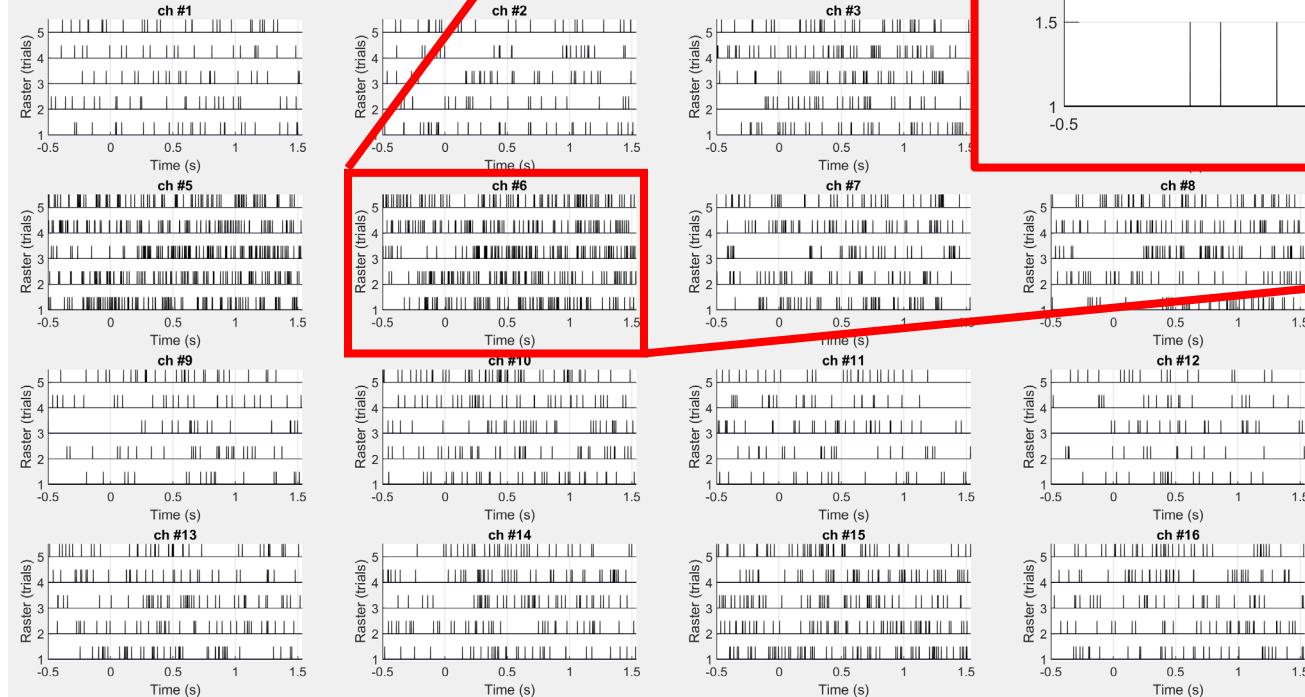


Figure 2: In problem 2, we were asked to re-organize the filtered data into a matrix with size, trial_samples x #_of_stimulations. We would then specify the threshold: (mean of filtered data)-3.3(std deviation of filtered data). The multiplier was selected based on the well-established property of normally distributed signals (red box): 99.7-99.9% of those signals will lie within +/- 3 standard deviations of the mean. This was visually and informally confirmed in Figure 1.b.

Figure 3.a: Raster plot for 5 traces from channel 6 using professor-provided `plot_raster` function. The raster matrix was made by finding the indices of threshold crossing that are more than 1 sample away from each other.



Cont'd: It was difficult to show the temporality criterion of causality between stimulus presentation and neural response, since the raster plots hardly seemed to burst across trials to the periodically presented stimulus, shown at time 0 in the detailed close-up of raster plot for channel #6 with only 5 traces selected from the 64 possible.

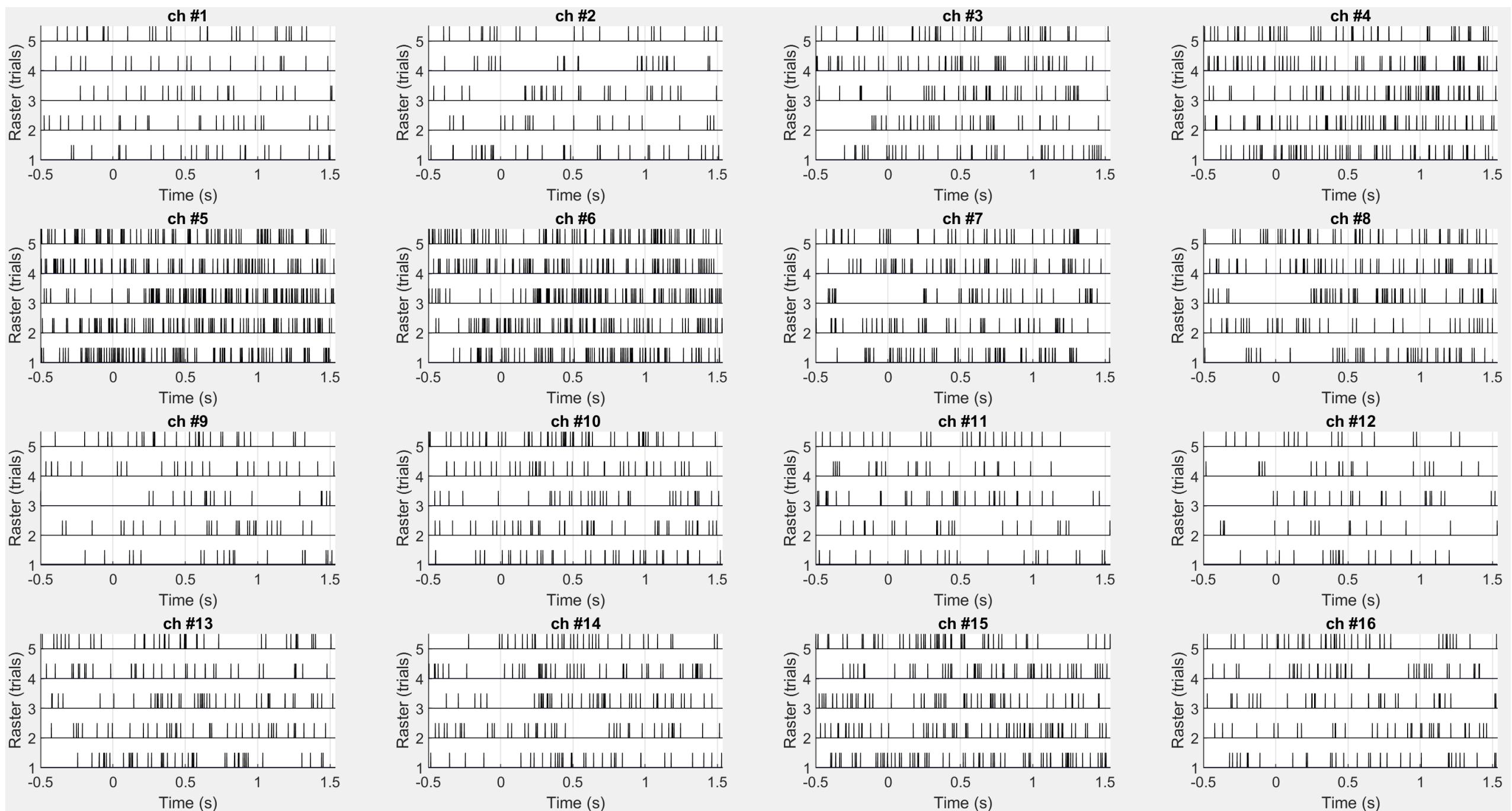


Figure 3.b: Enlarged 4×4 array of raster plots with every 12th trial (out of 64 trials) shown, for a total of 5 traces per channel

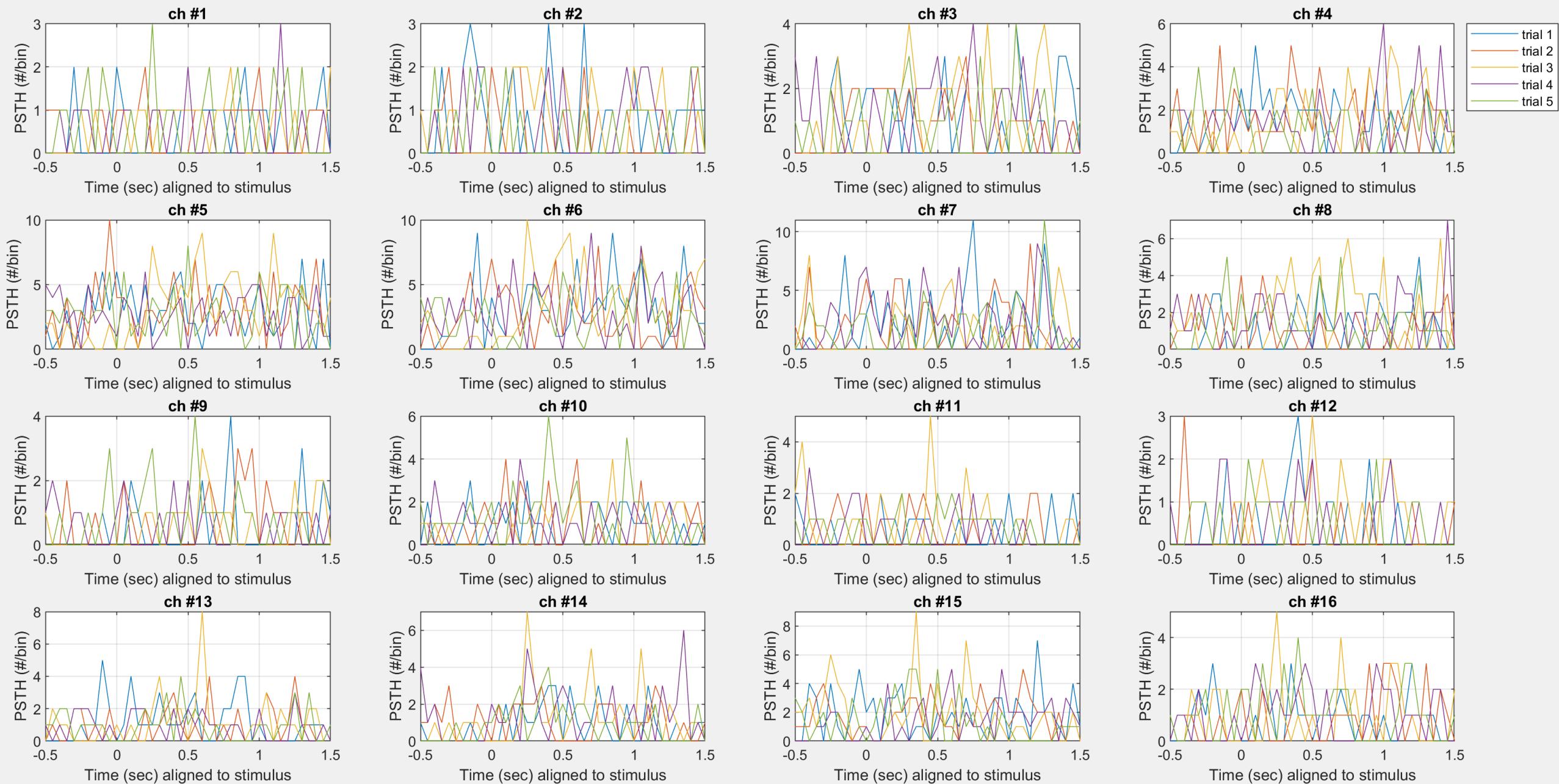


Figure 4.a: 4 x 4 array of PSTH plots with every 12th trial (out of 64 trials) shown, for a total of 5 traces per channel

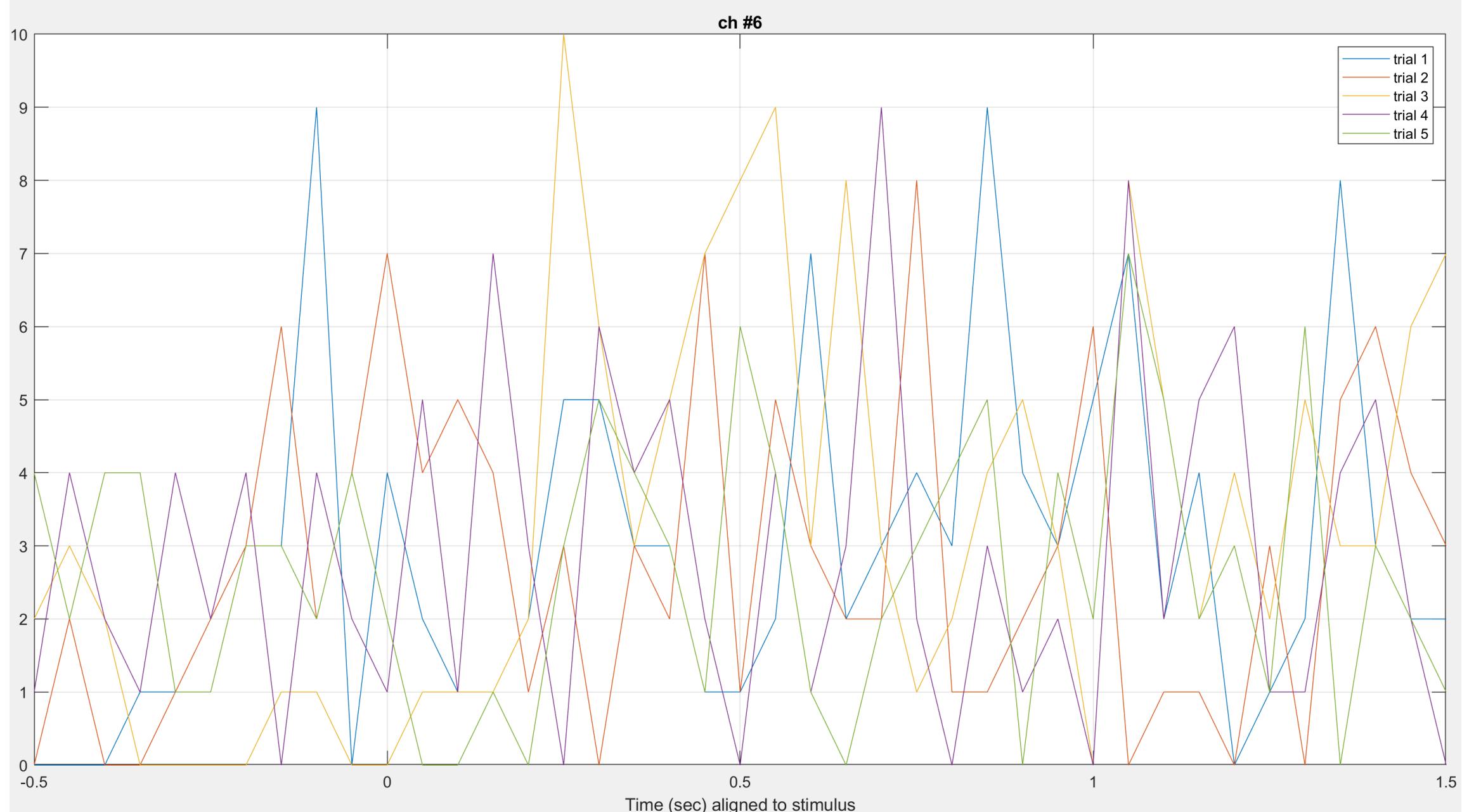


Figure 4.b: Enlarged PSTH plots with every 12th trial (out of 64 trials) shown for channel 6

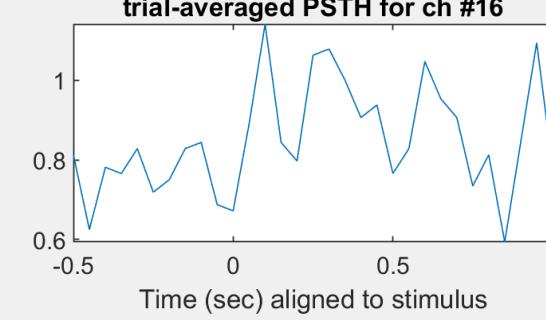
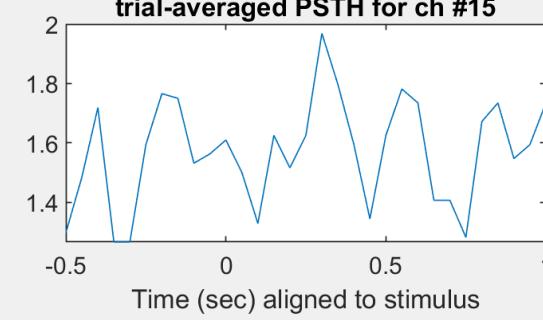
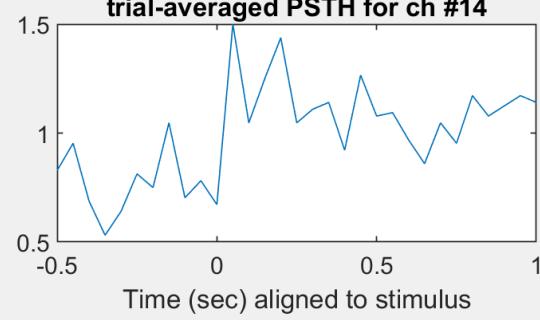
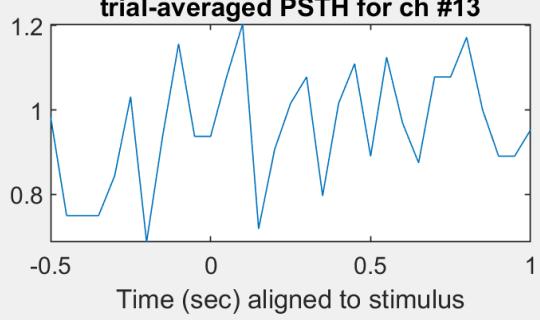
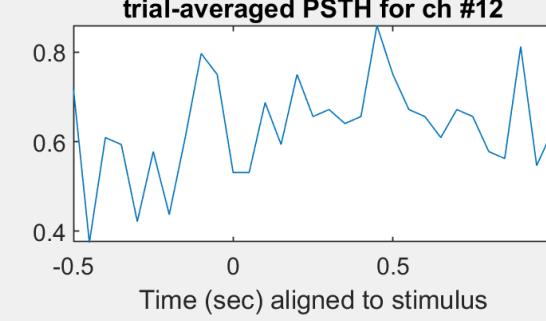
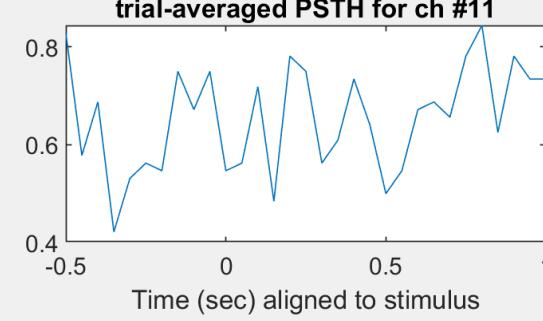
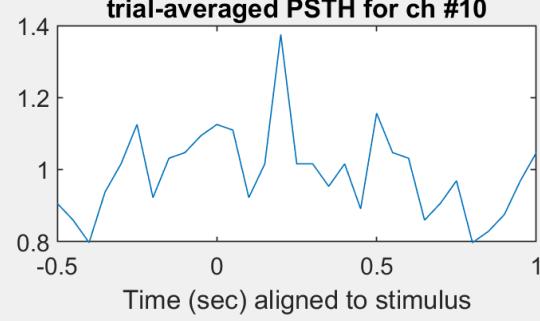
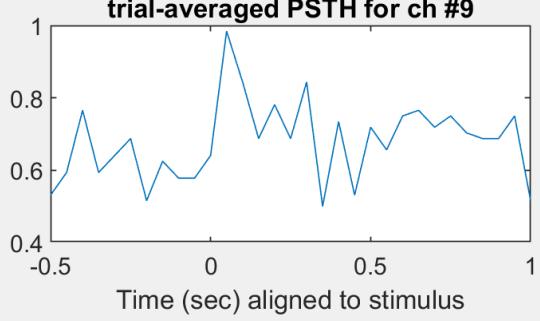
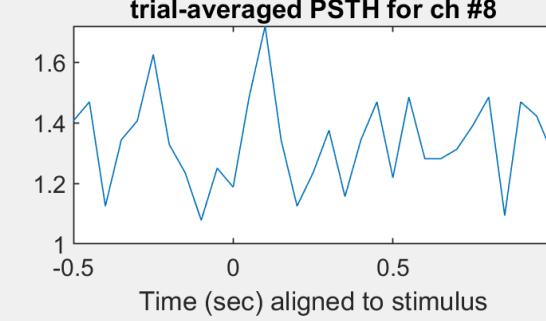
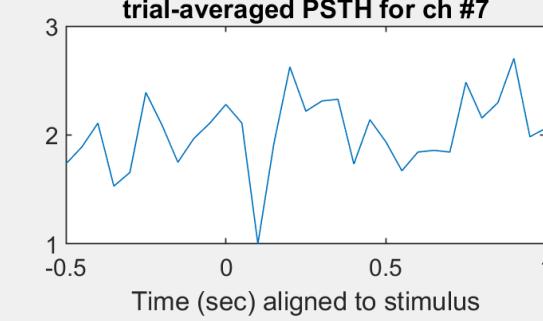
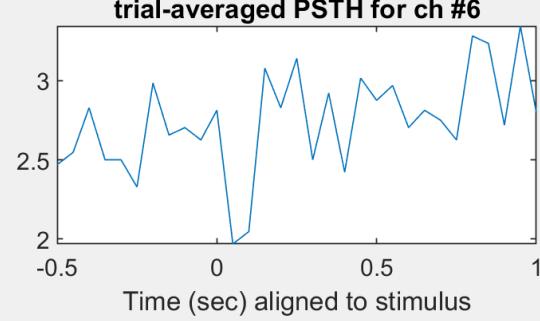
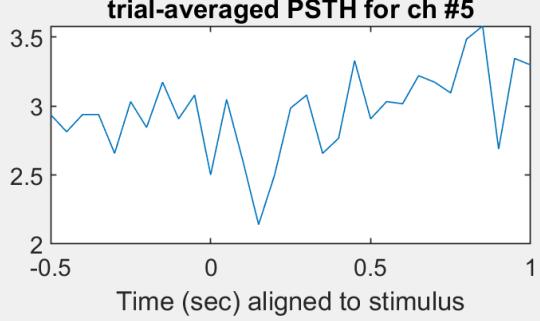
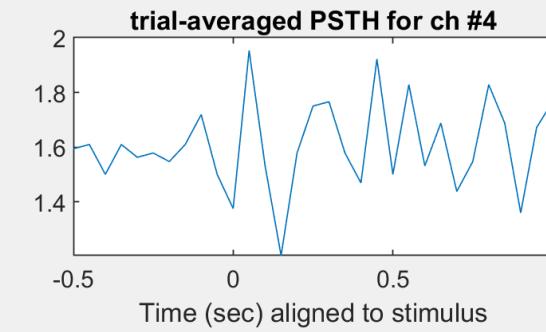
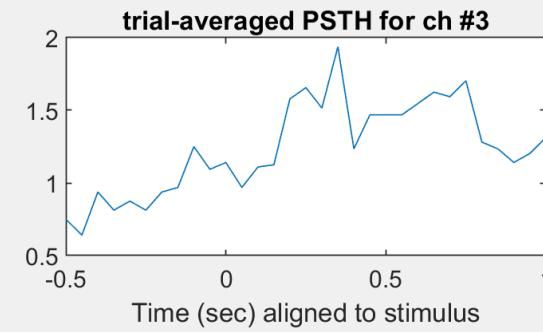
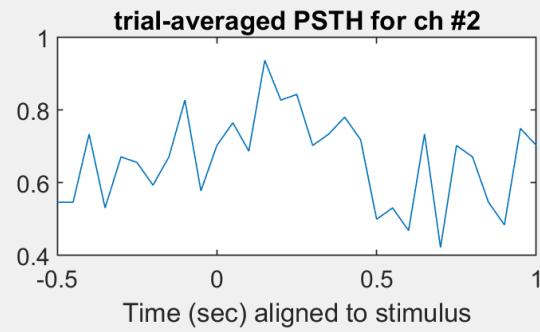
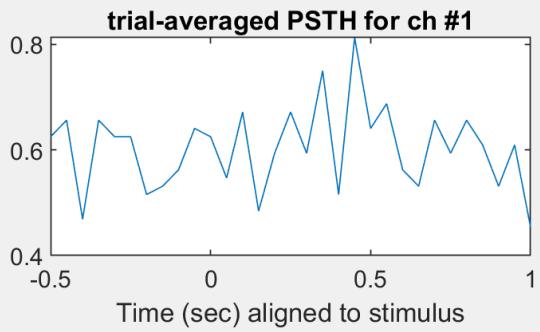


Figure 4.c: After averaging across trials, a PSTH was made for each channel.

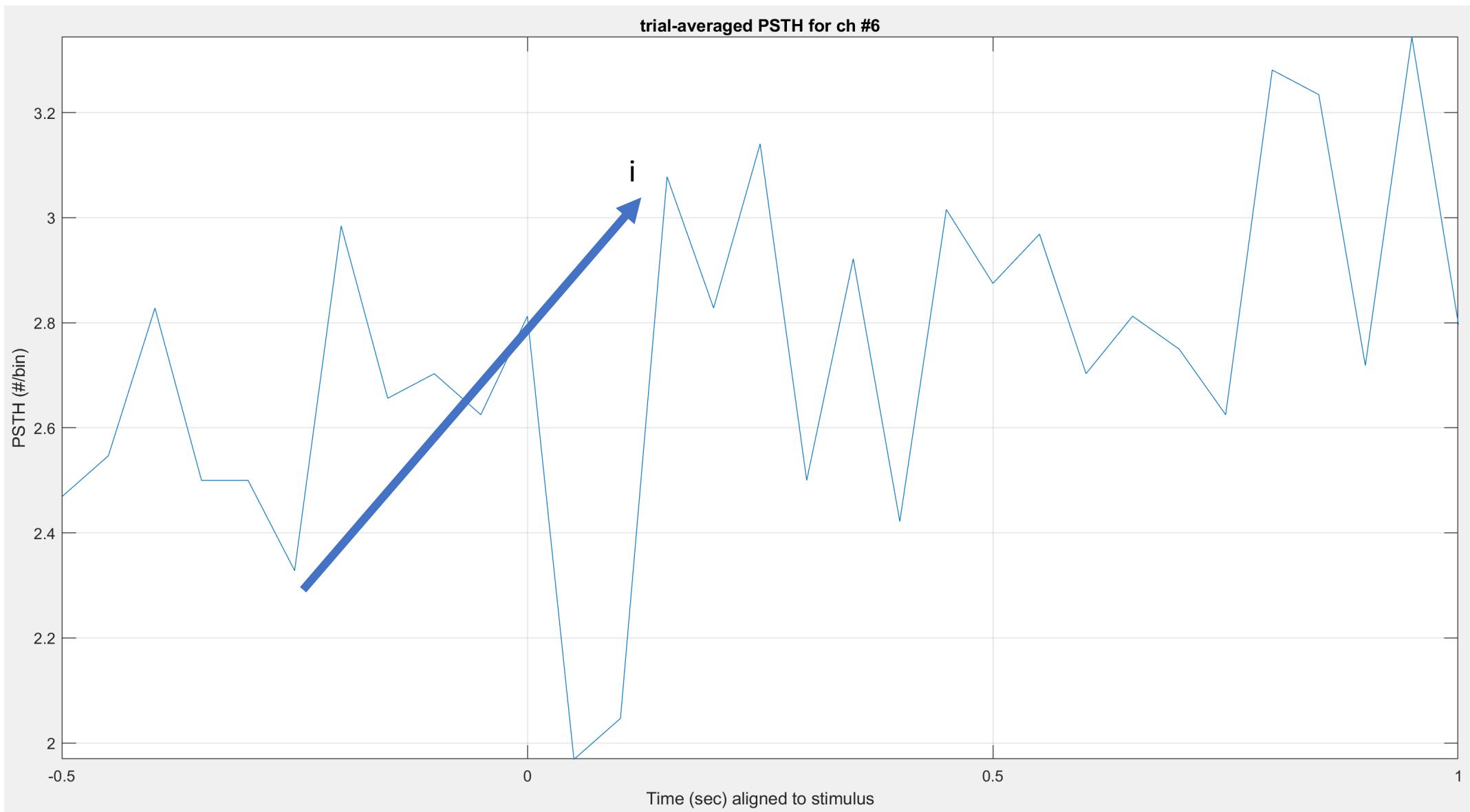


Figure 5: After averaging across trials, a PSTH was made for each channel. The peri-stimulus time histogram (PSTH) is for the average number of spikes sampled per bin over the course of the PSTH time vector, which is aligned to stimulus presentation at time = 0. The average rise in spike count encompassing a region of time before and during stimulus presentation (arrow i) was estimated using the slope formula:

$$(3.1 - 2.3 \text{ spikes/sec}) / [0.2 - (-0.25)\text{s}] = 0.8 / 0.45 = \sim 1.778 \text{ spikes/bin/sec.}$$

trial-averaged PSTH velocity as a function of depth/channel

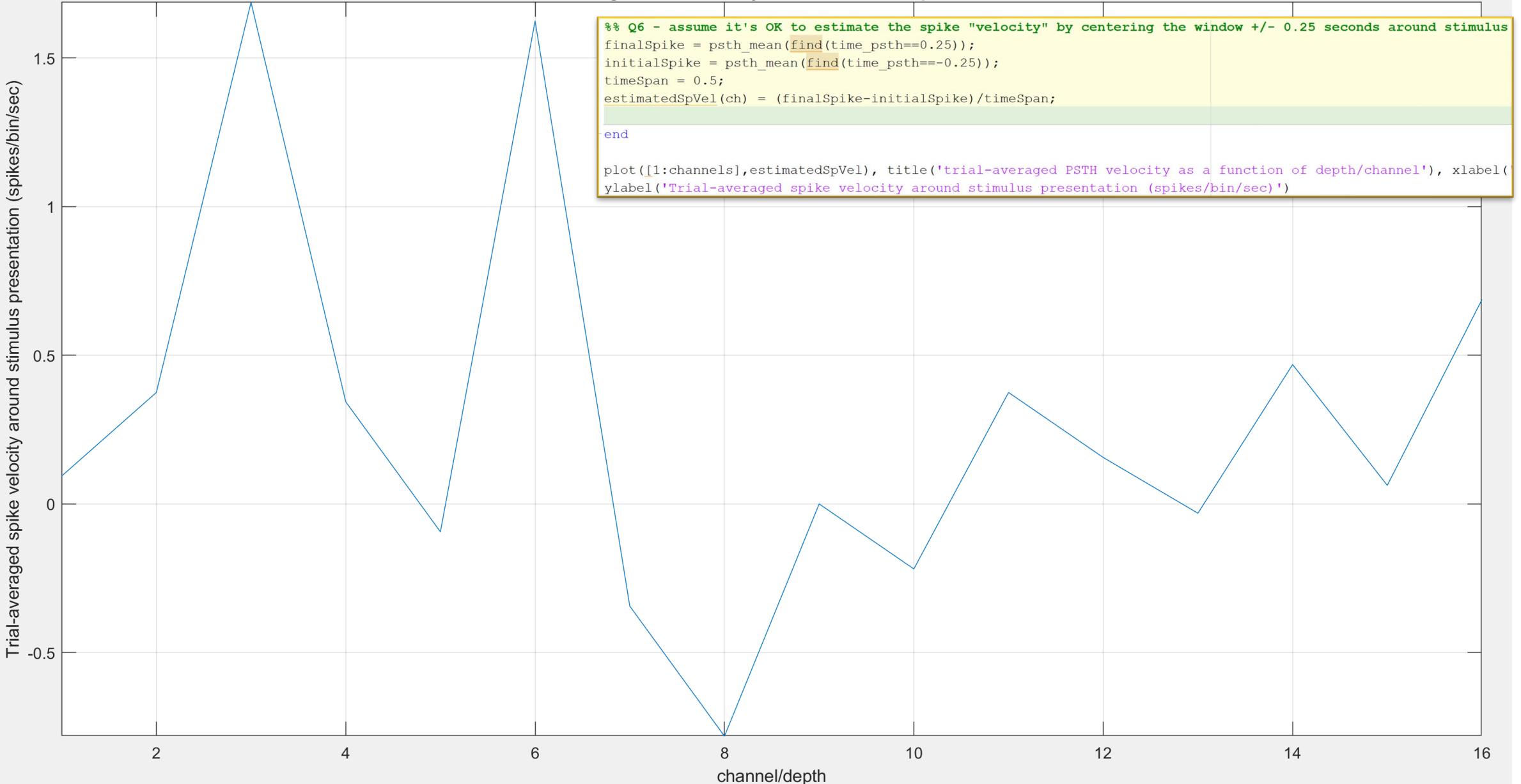


Figure 6: I estimated the change in spikes around the stimulus time by using a function (orange inset). The channels with the most change in spike velocity appear to channels 3 and 6, which are relatively superficial compared to the higher numbered channels

Accompanying Questions

- Neurons are electrically excitable and fire by changing their electrical potential. Glial cells—which are not generally excitable but have voltage-dependent channels and, like neurons, change membrane potentials—support, nourish, outnumber, and protect neurons. For example, some astrocytes, a type of glial cell, are excitable. doi: [10.1016/j.neuint.2011.12.001](https://doi.org/10.1016/j.neuint.2011.12.001). Epub 2011
- Synaptic potentials oscillate at a lower frequency than action potentials. Even though intra-cellularly recorded action potentials have a waveform that appears flipped from extra-cellular recordings, action potentials have a frequency around 1kHz, and can therefore be separated by an appropriate filter.

Accompanying Questions

- If there's no stimulus, there's no “peri-stimulus.” From what I understand, neurons respond to a relevant stimulus by increasing its firing rate, but neurons can also contribute to the “production” of actions. A histogram can still be made by binning and counting the various inter-spike intervals (ISI). ISI histograms can give information about the neuron's spontaneous activity, without an evoked stimulus, and enable us to see if neurons are phase-locked.