NCSI PROJECT

NAME: SOHINI GUPTA

ROLL NO:20EE10087

The tuning curves is a semi log graph. The frequency is in log scale. According to what we have learnt in theory the peaking i.e., maximum spiking rate should be visible around the best frequency of the Auditory nerve.

Observation: Converting 500Hz to log scale, the value comes around '2.7'. The maximum spiking rate is indeed near to 500Hz which is the best frequency of the Auditory nerve. The 2.7 line indicated in figure 1. is just for reference.

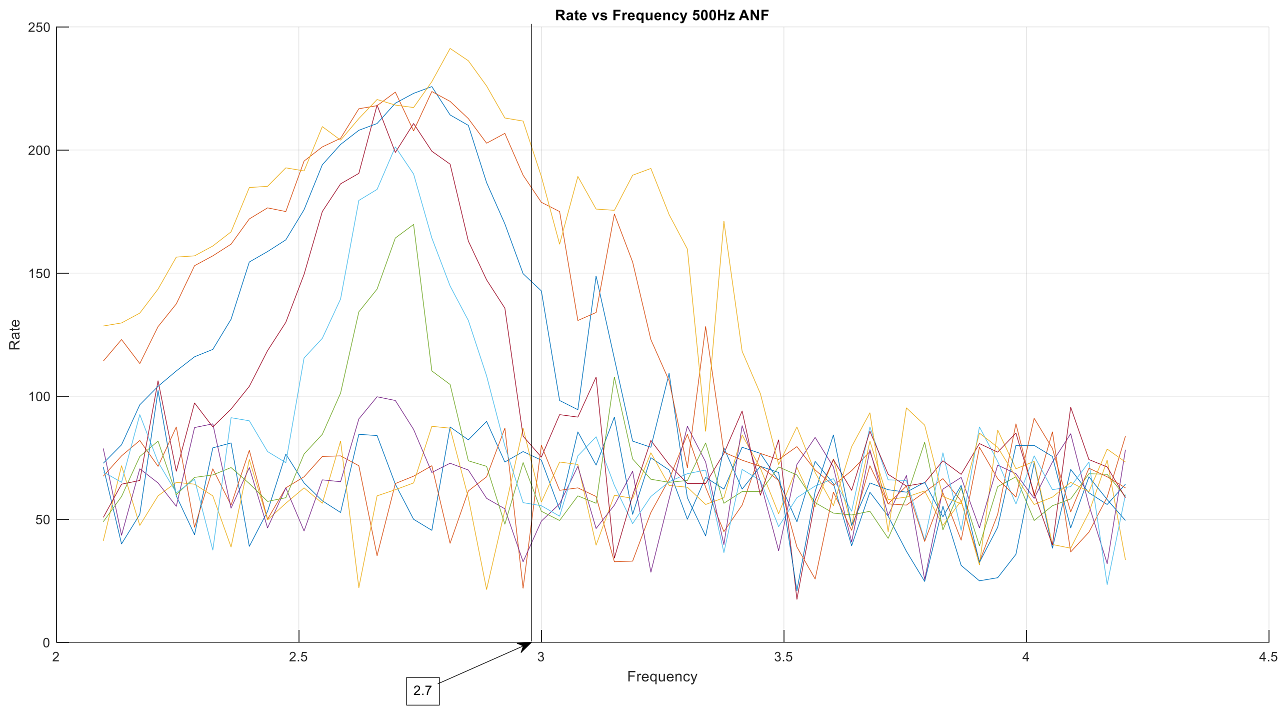


Figure 1.

Observation: Converting 4000Hz to log scale, the value comes around '3.6'. The maximum spiking rate is indeed near to 4000Hz which is the best frequency of the Auditory nerve. The 3.6 line indicated in figure 2. is just for reference.

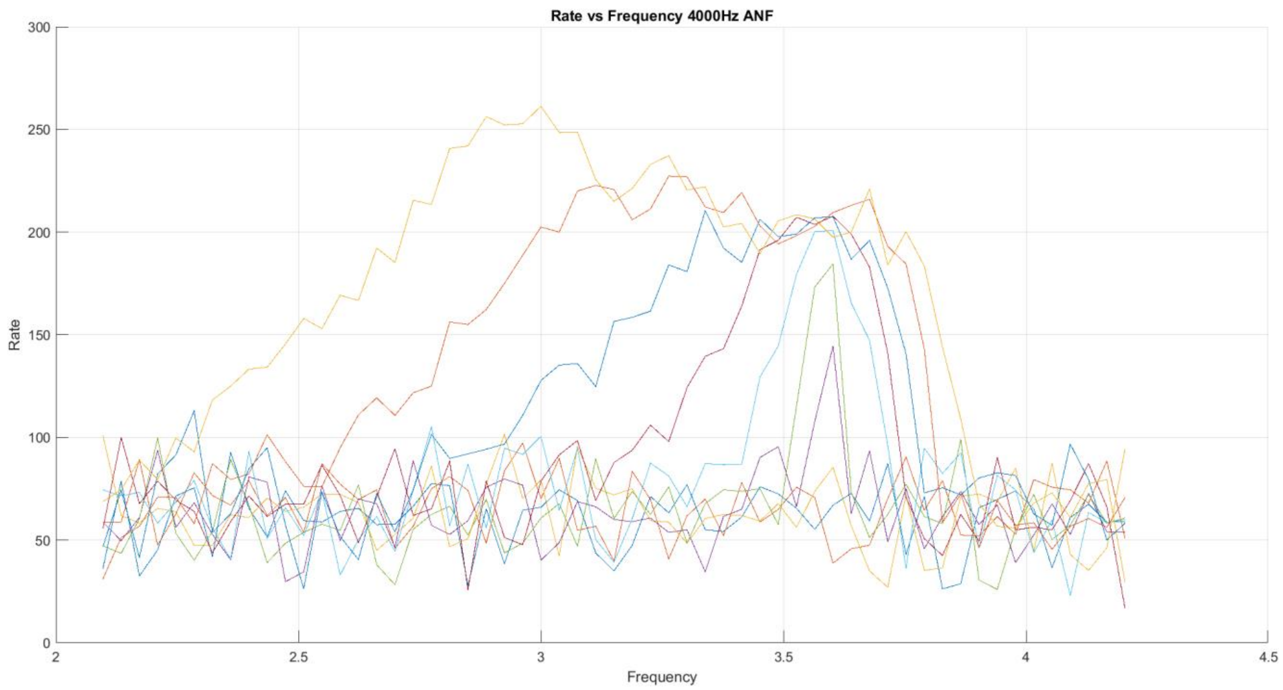
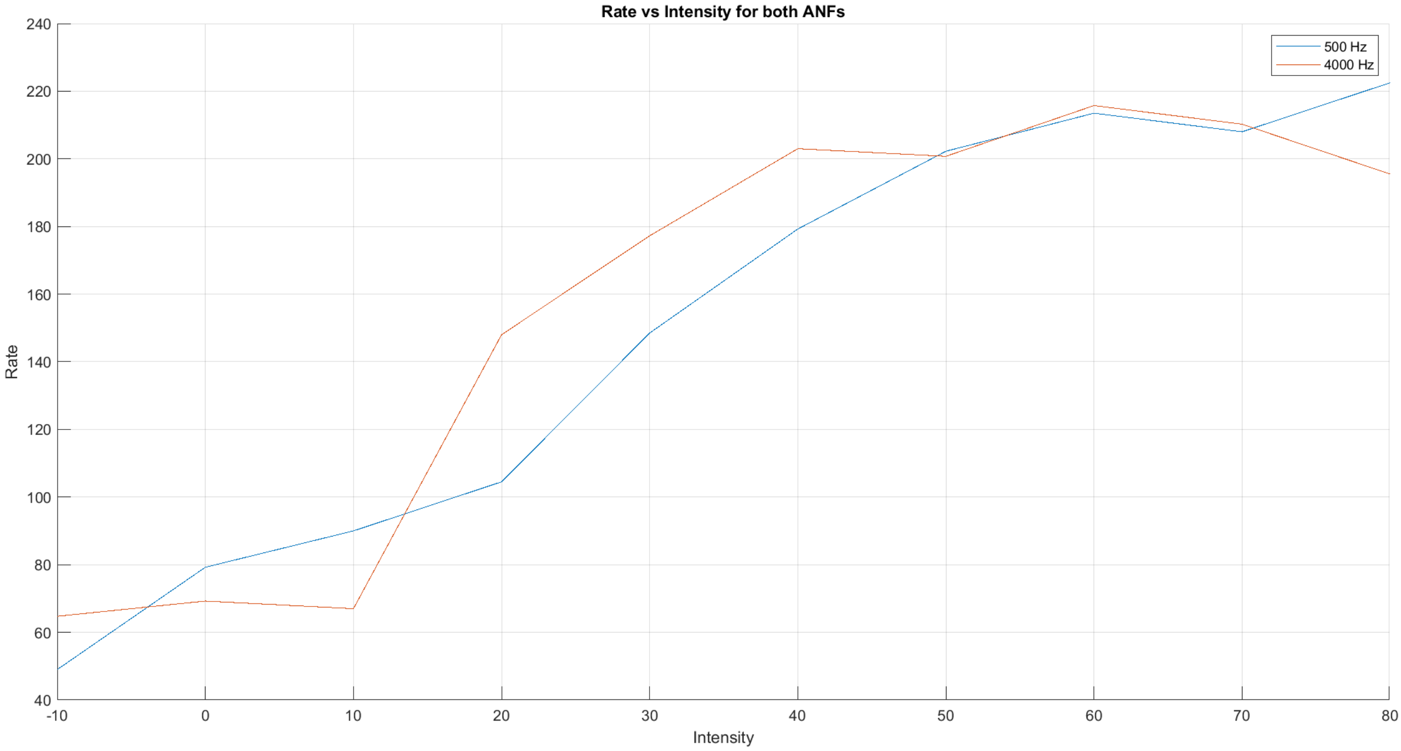


Figure 2



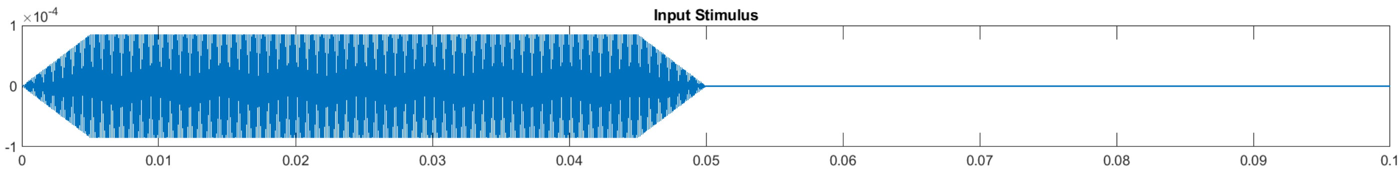
OBSERVATIONS:

- At low intensities, the ANFs show a low response rate and a narrow tuning curve centred around their BF.
- As the intensity increases, the response rate increases and the tuning curve becomes broader, responding to a wider range of frequencies around the BF.
- The tuning curve width at a given intensity depends on the BF of the ANF, with higher BF ANFs having broader tuning curves than lower BF ANFs.
- At high intensities, the ANFs may show a saturation effect, where the response rate reaches a maximum and does not increase further with increasing intensity.
- The rate vs. intensity function for the BF tone of each ANF shows a sigmoidal shape, with a threshold intensity below which there is little or no response, a dynamic range where the response rate increases with increasing intensity, and a saturation level above which the response rate plateaus.

Overall, the simulations show that the response of ANFs to auditory stimuli depends on both the frequency and intensity of the stimulus, and that different ANFs have different tuning properties and dynamic ranges.

Question 2:

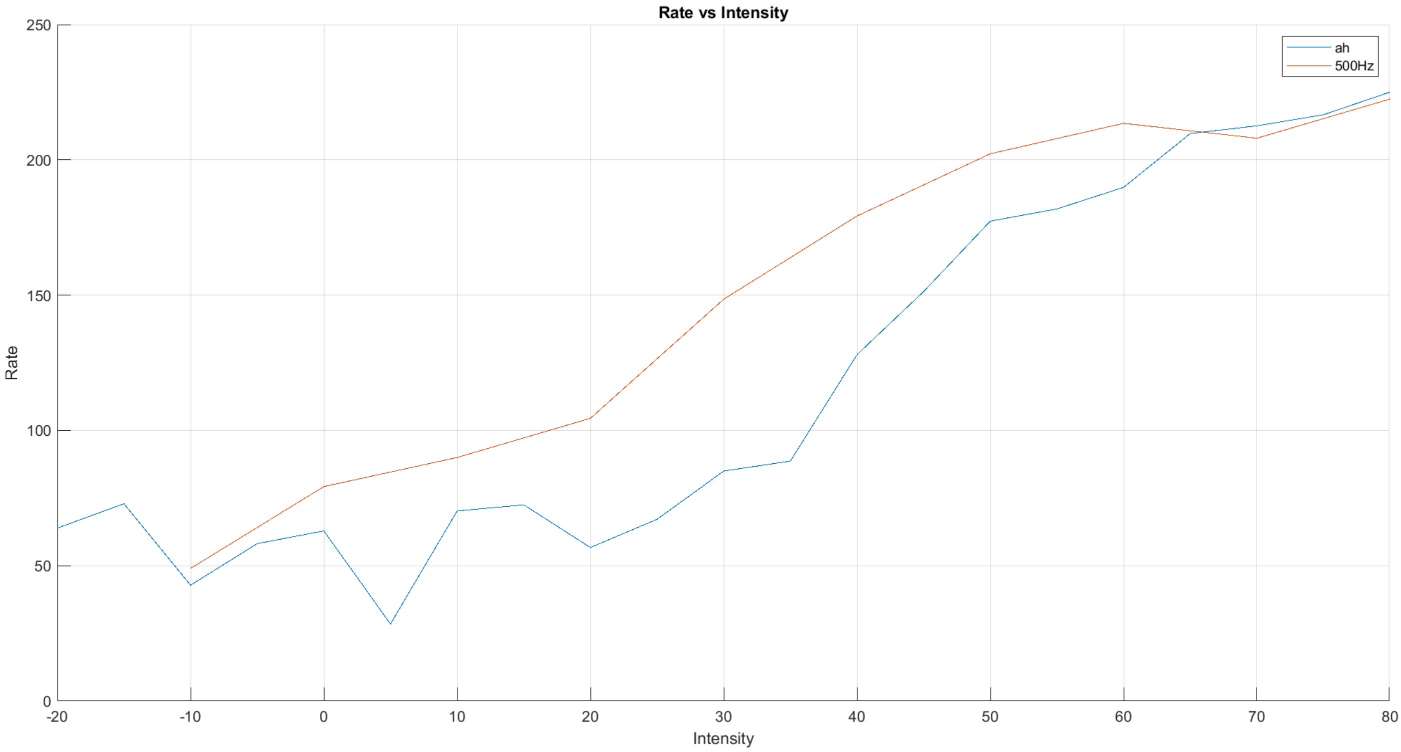
It is to note that we use ramped stimulus at the beginning and end of an auditory stimulus to minimize the impact of the stimulus onset and offset transients on the neural response of the auditory nerve. When a sound stimulus starts or stops abruptly, it generates a rapid change in sound pressure that can cause a transient response in the auditory system. This transient response can distort the representation of the stimulus. By using a ramped stimulus, the sound pressure gradually increases or decreases over time, reducing the abruptness of the onset and offset and minimizing the transient response. The following diagram shows how a ramped stimulus looks like:



So, we will ramp the audio likewise because it will be a stimulus to auditory nerve.

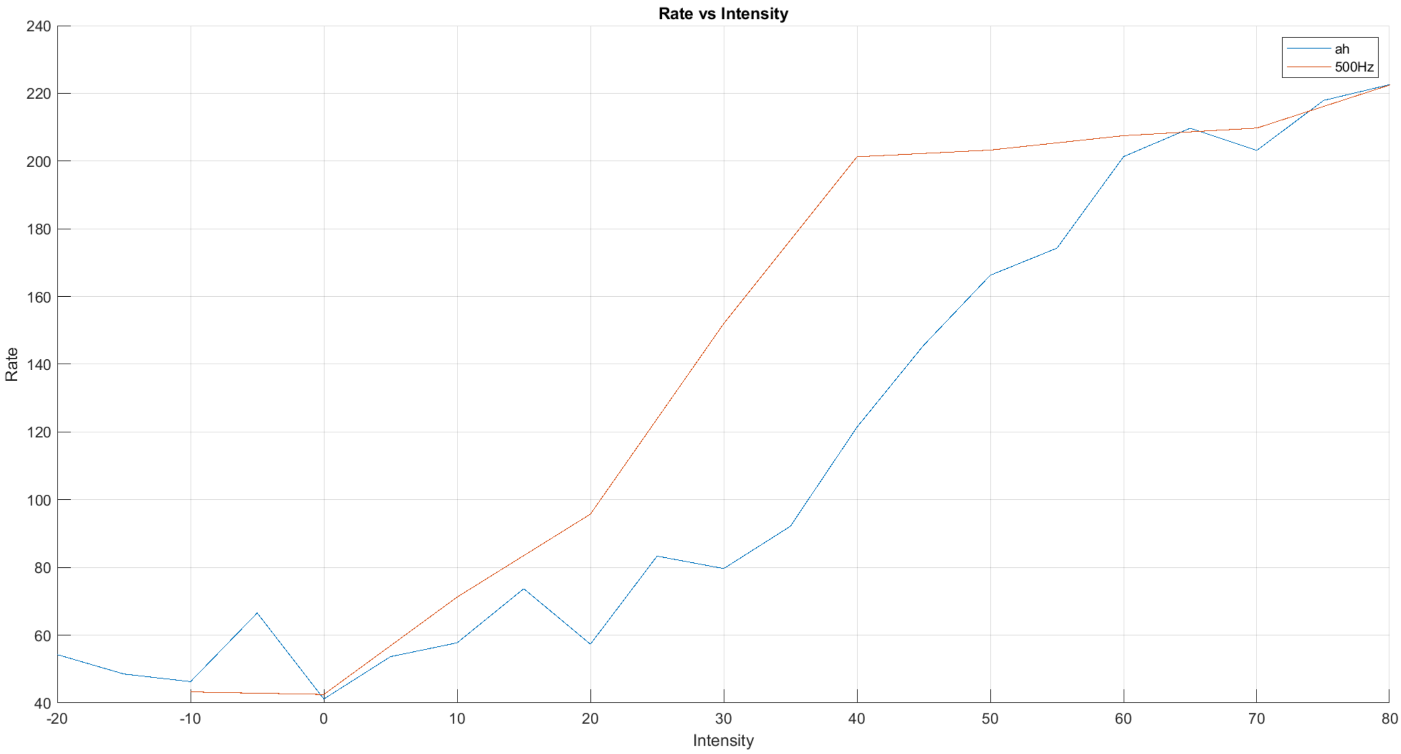
Figure 4

Two diagrams of rate VS intensity for both “ah” and 500Hz frequency has been attached to show the generality of the comparisons:



Threshold for “ah” =20 dB and saturation intensity= 70 dB

Threshold for 500Hz= 0 dB and saturation intensity = 50 dB



Threshold for “ah” =20 dB and saturation intensity= 60 dB

Threshold for 500Hz= 0 dB and saturation intensity = 40 dB

Comparison based on observation:

- 500Hz has a much lower threshold and lower saturation intensity
- the rate for the best frequency in the dynamic range is higher.

After generating the rate VS intensity graph we choose intensities in the three ranges i) 0 dB (where it does not cross the threshold), ii) 40dB (in the dynamic region) iii) 80 dB (saturation region).

The spectrogram of the original speech signal (the speech is not multiplied by with appropriate window size (25.6 ms hanning windows and overlap of successive windows by 50%, that is, a resolution of 12.8 ms).

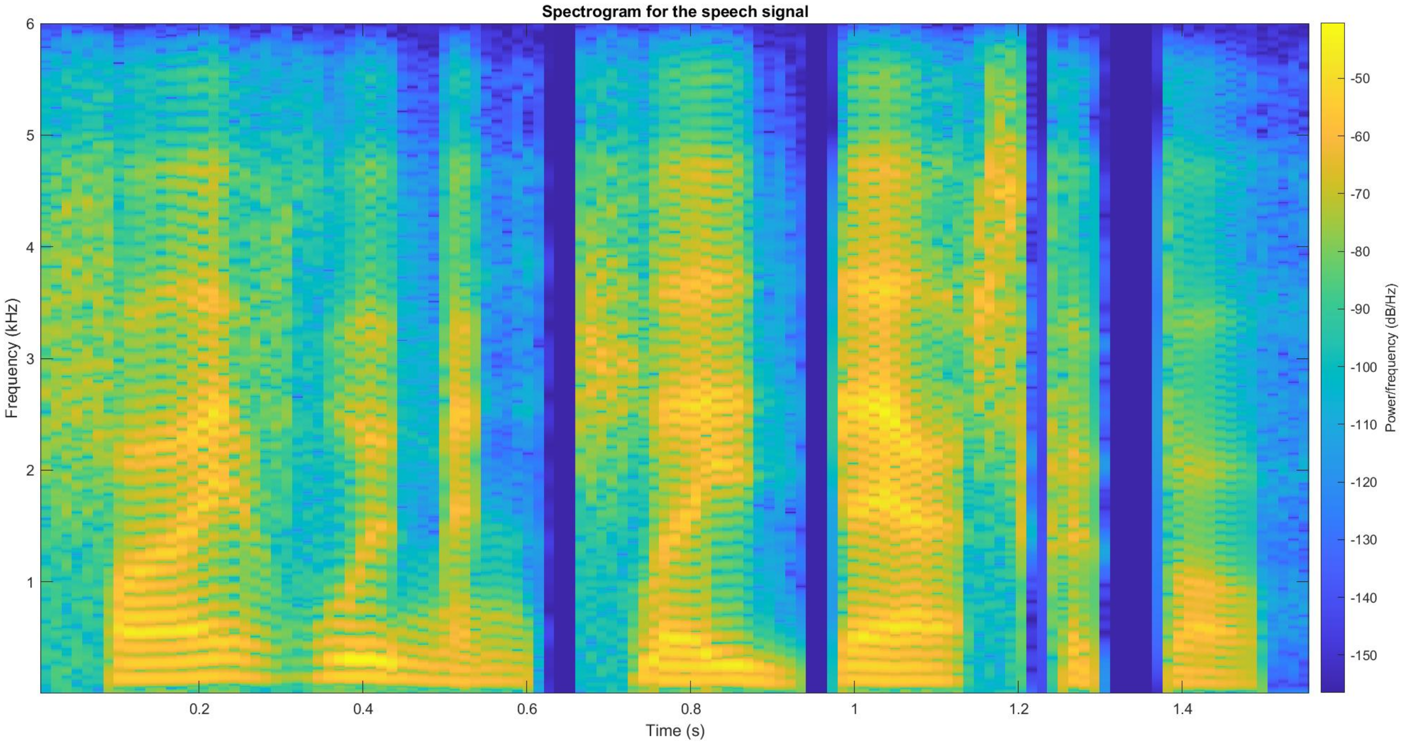


Figure 5

Now considering different window sizes, as listed in the question. Then the psth values are averaged within the window, as it slides over the entire response. These are plotted in a manner akin to a spectrogram, the ANF frequencies being on the y-axis, time on the x-axis, and the colour of a spot representing its rate. The plots turn out to be very similar to the actual spectrogram.

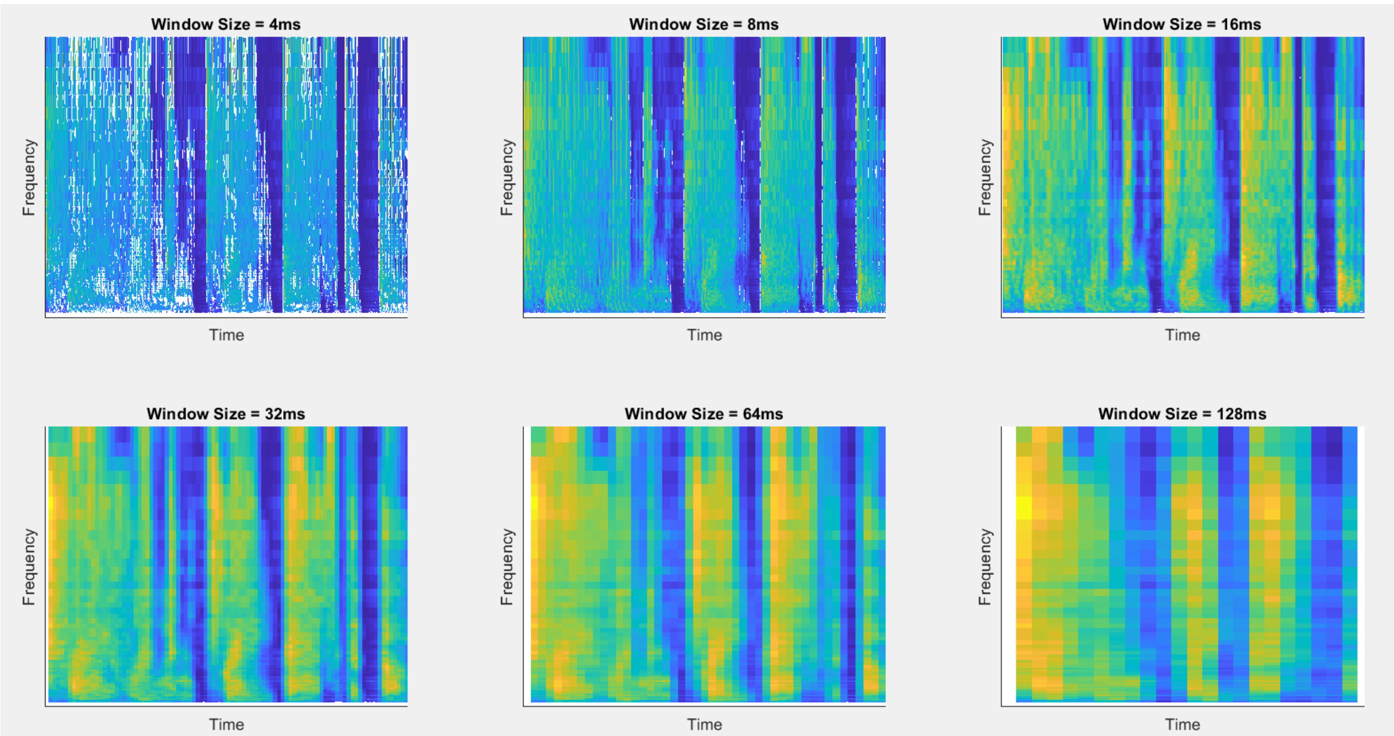


Figure 6

Question 3

The discrete Fourier transform (DFT) of the PSTHs for each window, will give information about the frequency components of the neural response. The frequency at which the DFT has the highest magnitude (i.e., the peak frequency) corresponds to the frequency to which the fiber is phase-locked.

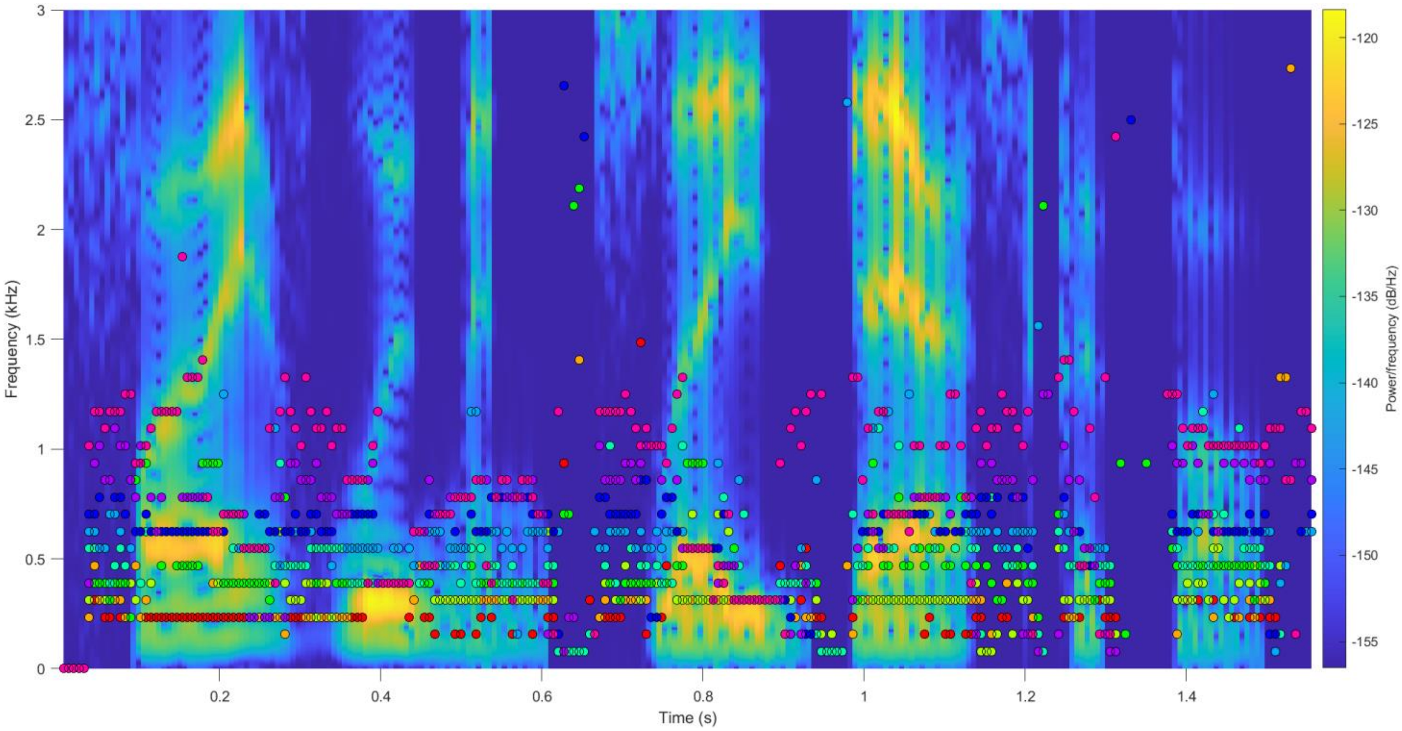


Figure 7

By analysing the dominant frequency at which each fibre is phase-locked, we can gain insights into the neural coding of different frequencies in the auditory system. For example, fibres that are most phase-locked to low frequencies may be specialized for encoding temporal features of sounds, while fibres that are most phase-locked to high frequencies may be more sensitive to spectral information.