Introduction

The aim of this laboratory exercise was to classify single units recorded from the cochlear nucleus on the basis of their PST and interval histogram shapes.

We were provided with a tape recording of data from an experiment (anesthetized preparation) performed by Dr. Peter Cariani. We used the computer program LabVIEW to construct PST and interval histograms. The following sections describe results and classification of neurons.

Results

The table in figure 1 summarizes the classification of neurons based on the shapes of PST and interval histograms. The histograms are shown in figures at the end of the report. Classification was done at sound levels 30 dB above threshold and these levels are shown in the table. Also shown in the table are ratings for the quality of spikes. The ratings (a), (b) and (c) express relative difficulty in discriminating spikes against a background of noise. As one progresses from (a) to (c), the difficulty level increases.

Classification

- 34-1: This unit is an onset chopper and it is apparent from the characteristic shape of the PSTH.
- 35-1: This is a pauser unit. There is pause of approximately 5 ms after the initial peak in the PSTH.
- 35-4: This unit also looks like a pauser. There is a relative pause of approximately 5 ms after the initial peak in the PSTH.
- 35-5: This unit is a transient chopper. Distinct chopping can be observed in the beginning of the PSTH but it fades away later.
- 35-9: This unit has a low CF and appears to be phase-locked. It has a very high spontaneous rate and one can observe spikes all over in the interval histogram. However, the strong initial peak in the interval histogram suggests that the cell is probably a sustained chopper.
<table>
<thead>
<tr>
<th>Unit</th>
<th>CF kHz</th>
<th>Level dB SPL</th>
<th>Unit Type</th>
<th>Spike Quality</th>
<th>Figure</th>
<th>Cell Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>34-1</td>
<td>8.8</td>
<td>50</td>
<td>Onset Chopper</td>
<td>(a)</td>
<td>2</td>
<td>Giant or Stellate (PVCN)</td>
</tr>
<tr>
<td>35-1</td>
<td>1.35</td>
<td>55</td>
<td>Pauser</td>
<td>(a)</td>
<td>3</td>
<td>Fusiform or Elongate (DCN)</td>
</tr>
<tr>
<td>35-4</td>
<td>1.4</td>
<td>45</td>
<td>Pauser</td>
<td>(b)</td>
<td>4</td>
<td>Fusiform or Elongate (DCN)</td>
</tr>
<tr>
<td>35-5</td>
<td>5.9</td>
<td>55</td>
<td>Transient Chopper</td>
<td>(a)</td>
<td>5</td>
<td>Stellate (PVCN)</td>
</tr>
<tr>
<td>35-9</td>
<td>0.105</td>
<td>60</td>
<td>Phase Locked</td>
<td>(b)</td>
<td>6</td>
<td>Stellate (AVCN)?</td>
</tr>
<tr>
<td>35-24b</td>
<td>33</td>
<td>55</td>
<td>Primary Like</td>
<td>(b)</td>
<td>7</td>
<td>Bushy (AVCN)</td>
</tr>
<tr>
<td>35-36</td>
<td>2.29</td>
<td>50</td>
<td>Primary Like</td>
<td>(b)</td>
<td>8</td>
<td>Bushy (AVCN)</td>
</tr>
</tbody>
</table>

Figure 1: Classification of Neurons

- 35-24b: This is a primary-like unit. Both the PST and interval histograms have shapes characteristic to primary-like units.
- 35-36: This too is a primary-like unit. The histograms have shapes characteristic to primary-like units.

Effect of sound level

We studied the effect of sound level on PST shape for the unit 35-5. Figures 9, 10 and 5 show histograms for this unit for levels 25 dB, 40 dB and 55 dB respectively. One can observe chopping at all three levels. However, there are some differences. At 25 dB, the peak in the interval histogram has a value of around 500 spikes/bin. Though small in number, there are inter-spike-intervals with values as large as 12 ms. At 40 dB and 55 dB, the peaks are much higher and there are almost no inter-spike-intervals greater than 4 ms. Thus, the chopping characteristic increases with level. But there is no difference in the rate of chopping, peaks occur in the interval histogram at around 1.5 ms for all three levels. In some chopper units, a level sufficiently high can produce a primary-like PSTH but as we can see, 55 dB is not high enough for the unit 35-5 to result in a primary-like PSTH.

Questions and Answers

Anatomical Cell Types

Anatomical cell type expected of each unit is mentioned in the table (figure 1).

Problem of simultaneous recording

A PST histogram like the one in figure 4 might be expected if the recording is simultaneously from a chopper unit and an onset unit. When recording from a single unit, the waveforms
of all spikes observed on the oscilloscope are very similar. However, if the spike waveforms are not similar, it is a hint that one is recording simultaneously from more than one unit.

**Observing a notch in a phase-locked unit**

Making the bin-width very small will minimize the phase-locking display in the PSTH, perhaps making the notch more visible.

**False triggers**

If there are spikes in the interval histogram in the very beginning, corresponding to intervals shorter than the refractory period, one can be sure that such spikes are false triggers.

**High sound levels**

The response of neurons will be affected by the level of tone bursts presented. The response might be saturated or qualitatively different from the usual response. For example, chopper units might generate primary-like PST histograms when the stimulus is presented at high levels.

**Primary-like unit and primary-like PSTH**

A primary-like PSTH can result from units other than primary-like units. As an example, a chopper unit might produce a primary like PSTH if presented with high sound level stimulus.

**Prepotential units**

One can increase the gain just enough so as to trigger at every pre-potential. The PSTH would look like two identical histograms shifted and superimposed. In other words, peaks would occur in pairs and the time difference between the peaks would correspond to the synaptic delay.

**Place of recording**

The composition of the entire data set suggests that most units were recorded from AVCN. One plausible electrode pathway is DCN → PVCN → AVCN.
Figure 2: Unit 34-1, CF = 8.8 kHz, Level = 50 dB SPL; Onset Chopper
Figure 3: Unit 35-1, CF = 1.35 kHz, Level = 55 dB SPL; Pauser
Figure 4: Unit 35-4, CF = 1.4 kHz, Level = 45 dB SPL; Pauser
Figure 5: Unit 35-5, CF = 5.9 kHz, Level = 55 dB SPL; Transient Chopper
Figure 6: Unit 35-9, CF = 105 Hz, Level = 60 dB SPL; Phase-locked
Figure 7: Unit 35-24b, CF = 33 kHz, Level = 55 dB SPL; Primary Like
Figure 8: Unit 35-36, CF = 2.29 kHz, Level = 50 dB SPL; Primary Like
Figure 9: Unit 35-5, CF = 5.9 kHz, Level = 25 dB SPL; Chopper
Figure 10: Unit 35-5, CF = 5.9 kHz, Level = 40 dB SPL; Chopper