INTRODUCTION

Neurons in visual cortex area MT display diverse temporal waveforms in response to step changes in visual motion; one of the most prominent features in their responses is a transient peak which often occurs before the sustained response. There have been suggestions that the spikes in this transient period have 'special' information properties.

RESULTS

1. Transient response characteristics

Responses were binned with 5 ms resolution. The 'transient' response was considered to be the peak firing rate in any bin (100 ms after stimulus onset); the sustained response was the average over bins between 180 & 320 ms.

Four datasets were extracted:

- T/R ratio > Time to peak < Neurons
- D0 0 76
- D1 160 81
- D2 130 35
- D3 100 9

Responses for the most transiently effective stimulus for each of the 78 cells, sorted according to T/R ratio. The markers at left indicate dataset boundaries.

2. Fano factors: spike count variability

The Fano factor is the ratio between the variance and mean (over trials) of the spike count in a time window from 5 ms.

For the population of cells, it can be seen that the transient responses were more informative. This was not held up, however, when normalizing by the firing rates in the 5 ms time window.

There was no statistically significant difference in the number of bits per spike available in the transient compared to the sustained response period.

A two-tailed t-test does not reject the null hypothesis that the distributions are the same.

3. Shannon information content of spike counts

We calculated the Shannon mutual information contained by the responses in spike counts in 5 ms windows about direction of motion.

At left, we show instantaneous firing rate and spike count information in 5 ms bins relative to stimulus onset, for a typical cell.

For the population of cells, the response latency was on the order of 80 ms.

For these typical example cells, N = 2 ms bins were used, and wavelengths l = 6 (i.e. 12 ms windows).

During the sustained portion of the response, the effect of correlations was minimal.

4. Temporal information in transient spikes

The spike train for each trial can be represented by a binary string - the information content of this string is < in the spike counts over the same time window. We estimated the spike timing information using a Taylor series approach (1,2); this allows the temporal information to be broken down into individual components reflecting the instantaneous rate (firing rate) and pairwise interactions between spikes.

For the population of cells, the response latency was on the order of 80 ms.

During the sustained portion of the response, the effect of correlations was minimal.

SUMMARY

1. Spike count variability is lower in the transient than the sustained period of response.
2. Lower Fano Factors are correlated with high instantaneous firing rates, indicating that the relative refractory period might explain this.
3. Spike count information is higher in the transient.
4. The number of bits per spike is the same in the transient as in the sustained period.
5. The temporal information is dominated by the instantaneous firing rate term.
6. Correlations can lead to synergy or redundancy during onset and offset transients.