

# Two Coding Strategies for Communication Signals in a Population Rate Code

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It is generally believed that encoding of stimuli in the firing rate of single neurons strongly limits a rapid readout by higher-order neurons. A population rate code, however, is much better suited for high speed processing. Here we present recordings from electroreceptor afferents of the weakly electric fish *Apteronotus leptorhynchus* demonstrating that both coding schemes are employed within the *same* population of electroreceptor neurons for encoding communication signals (“chirps”) as determined by the timescale of the stimulus.

Small chirps (Fig. 1) generate short transients of about 14 ms duration that interrupt a periodic beat pattern ( $\Delta f$  less than 60 Hz). Single unit recordings showed that the high-pass properties of the cells induced by spike-frequency adaptation strongly enhance the firing frequency response to the chirps compared to the response to low (less than 30 Hz) beat frequencies (Benda et al., J. Neurosci. 25: 2312–2321, 2005).

During large chirps (Fig. 2) that last about 24 ms a high frequency beat ( $\Delta f$  larger than 100 Hz) is interrupted by a short period of smaller amplitude. The evoked spikes were phase locked to the fast beat and thus strongly synchronized. During the chirp, however, the spikes were desynchronized. Correspondingly the population activity showed a strong oscillation during the beat that is interrupted by a brief period of constant activity during the chirp.

In summary, two different coding schemes result in a clear change in the population activity in response to the chirps. 1) A redundant firing-rate code for the small chirps that is already visible in a single cell, and 2) a synergistic code for encoding large chirps that requires the whole population of receptor neurons to translate the change from synchrony to asynchrony into an interruption of the oscillation of the population rate.

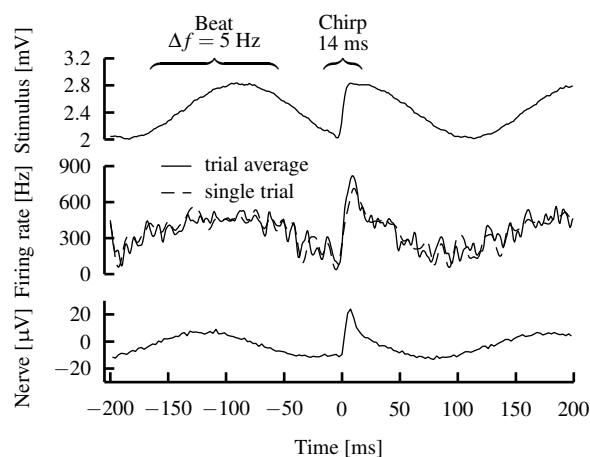


Figure 1: Redundant code for a small chirp at a slow beat. The single trial and trial averaged firing rate, as well as the population response (nerve) are all similar.

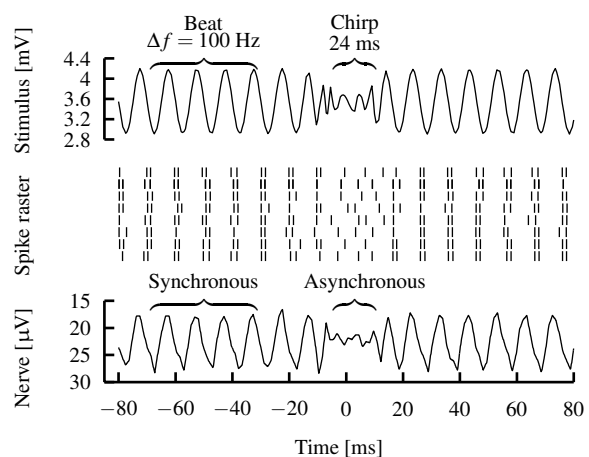


Figure 2: Synergistic code for a large chirp at a fast beat. The desynchronization induced by the chirp is a population signal.