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A neurocomputational model of temporal processing: evidence from sequence experiments

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Our world changes both in space and time, and our brain faces the challenge to cope with these changes in both dimensions. While substantial progress has been made on the way to understanding the neural substrate of e.g., spatial vision or sound localization, "the field of temporal processing is still at its infancy" [1]. There are many models of the neural substrate of this ability, but it is not easy to decide which model to use based on purely neuronal data. Psychophysical research on temporal processing makes it possible to formulate constraints on neuronal models.

We conducted a series of human experiments to study temporal variability under various conditions. Participants were presented with a sequence of identical intervals, containing a single interval which differed from the others by a small amount X at a random position. After the presentation, they had to judge the sequence as an even or an uneven rhythm. The minimal value of X for which the sequence was reliably judged as "uneven" was used as a measure for temporal variability. We found that this measure varies considerably with its position in the sequence. Thus, we could rule out a class of models that do not predict an adaptation effect. Furthermore, the mean threshold increases with the duration of the standard intervals, consistent with former results. In a subsequent experiment, we could show that variability does not depend on the total length of the sequence. This implies that the sequence in not processed as a whole and that effects of interval duration and sequence context can be separated into different processing stages.

We propose a computational model for the first stage. While it was long believed that timing errors increase linearly with the interval to be processed (Weber's law) [2], recent experiments show that for longer and shorter intervals, deviations from linearity occur [3]. Our model provides an explanation for both Weber's law and its deviations. It consists of a group of synfire chains, layered networks that are able to transmit a wave of neural activity through its layers with high temporal precision. These networks are able to convert temporal information into a quasi-spatial code. In a single chain, timing errors increase only with the square root of the interval length. We show that the experimentally observed error course results as the optimal solution from competition among several synfire chains with different transmission speeds.

References

1. Buonomano DV: **How do we tell time?** *Neuroscientist* 2002, **8:**42-51.
2. Gibbon J: **Scalar expectancy theory and Weber's law in animal timing.** *Psychol Rev* 1977, **84:**279-325.

3. Bizo LA, Chua JYM, Sanabria F, Killeen PR: **The failure of Weber's law in time perception and production.** *Behav Processes* 2005, **71:**201-210.