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NEURAL CODING

Timing is key in the olfactory system

> … temporal patterns of activation in the periphery can have an important functional effect on the coding of sensory information …

In principle, when populations of neurons encode sensory information, the combination of neurons activated, their rate of firing (rate coding) and the timing of their firing in relation to one another (temporal coding) could all be used to convey information. The importance of each coding strategy is, however, unclear. Now, Uchida and colleagues provide evidence for the involvement of temporal coding in the transmission of olfactory information.

Exposure to odours generates specific spatiotemporal patterns of activation in olfactory bulb neurons (OBNs). Here, the authors acquired extracellular recordings from piriform cortex neurons (PCNs), which are downstream of OBNs, while optogenetically stimulating the OBNs of channelrhodopsin 2-expressing mice. By varying the order of and time between (the lag) the presentation of two spots of light that stimulated different parts of the olfactory bulb, they assessed the sensitivity of PCNs to changes in temporal coding.

The authors found that the firing rates of PCNs were influenced by both the lag and the order of stimulus presentation. This indicates that information about the relative spike timing in OBNs is transmitted to higher-order neurons in the olfactory system.

What are the mechanisms by which variations in relative firing times can alter the firing of downstream neurons? The authors found that the sensitivity of many PCNs to the order of stimulus presentation was only apparent when there was a reasonably long lag between the first and second stimulus, indicating that delayed inhibition or delayed facilitation has a role in the generation of order sensitivity.

Finally, the authors investigated the relative importance of temporal- versus rate-coding in different parts of the olfactory system. A decoding analysis showed that in the olfactory bulb, the temporal features of neuronal firing more accurately predicted the order of the stimulus presentation than did the firing rate. However, predictions based on firing rate were more successful in the piriform cortex, indicating a progression from temporal- to rate-coding, as information moves from the periphery to central brain areas.

These findings indicate that temporal patterns of activation in the periphery can have an important functional effect on the coding of sensory information, at least in the olfactory system.

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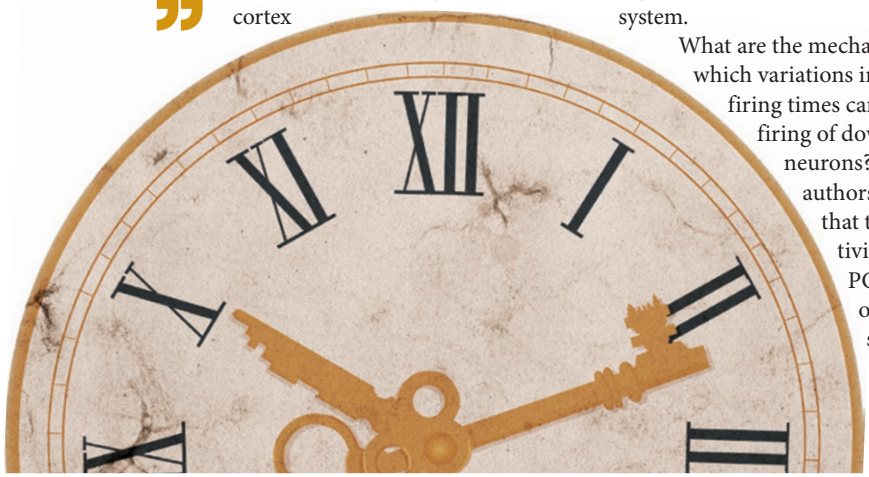

J. Vallis/NPG

ORIGINAL RESEARCH PAPER Haddad, R. *et al.* Olfactory cortical neurons read out a relative time code in the olfactory bulb. *Nature Neurosci.* 19 May 2013 (doi:10.1038/nn.3407)