

## **Coding 3D by 3V: How sensor motion constrains sensory coding**

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Rats use their whiskers (vibrissae) to localize and identify objects in their vicinity. We studied neuronal variables used by vibrissal receptors to encode the coordinates of object location in three dimensions. We found that the most efficient neural code for each of the three spatial dimensions is different: spatial (labeled-line) for the vertical (along whisker arcs), temporal for the horizontal axis (along whisker rows), and rate for the radial axis (from the face out). One possible advantage of such a triple coding scheme is increasing channel efficiency by multiplexing; the same neurons can convey information on three dimensions at the same time without losing accuracy or reliability. The fact that a neuron fires conveys information about the vertical coordinate of an object; the time of its firing, in relation to other the radial coordinate. The output signal of such a neuron can be conveyed in parallel to different readout circuits, each decoding one specific variable. Another possible advantage of triple coding is reducing ambiguity, and by this simplifying decoding algorithms; a given neuronal variable encodes only one coordinate and is not affected by other coordinates (orthogonal coding). The vibrissal system partially utilizes both these advantages, and also monitors coding efficiency via a delicate control of whisker motion. Understanding how optimal motor-controlled coding is achieved will most likely advance our understanding of sensory perception.