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The Organization of the Vagus Nerve

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We would like to present our latest findings on the followings [1]. Interoception, the ability to timely and precisely sense changes inside the body, is critical for survival. Vagal sensory neurons (VSNs) form an important body-to-brain connection, navigating visceral organs along body's rostral-caudal axis and diving across organ's surface-lumen axis into appropriate tissue layers. The brain can discriminate numerous body signals through VSNs, yet the underlying coding strategy remains poorly understood. Here we aim to understand the coding architecture of the vagal interoceptive system. We developed multiple state-of-the-art technologies including Projection-seq and vCatFISH to determine the precise neuronal identity based on their innervations and response patterns. We show that VSNs code visceral organ, tissue layer, and stimulus modality, three key features of an interoceptive signal, in different dimensions. Large-scale single-cell profiling of VSNs from seven major organs using multiplexed projection-barcodes reveals a 'visceral organ' dimension composed of differentially expressed gene modules coding organs along body's rostral-caudal axis. Surprisingly, we discover another 'tissue layer' dimension with gene modules coding VSN ending locations along organ's surface-lumen axis. Using calcium imaging-guided spatial transcriptomics, we show VSNs are organized into functional units to sense similar stimuli across organs and tissue layers, constituting a third 'stimulus modality' dimension. The three independent feature-coding dimensions together specify many parallel VSN pathways in a combinatorial fashion and facilitate complex VSN projection in the brainstem. Our study thus highlights a novel multidimensional coding architecture of the mammalian vagal interoceptive system for effective signal communication.

References:

[1] Zhao et al., Nature. (2022).