Efficient processing of multimodal information is pivotal for proper behavioral performance. The mechanisms that neural networks utilize to encode distinct sensory modalities and control motor activity, however, remain unknown. We studied the role of premotor network activity in multimodal processing and motor output control in the crustacean stomatogastric nervous system. Using voltage-sensitive dye imaging of the commissural ganglion premotor region, we found that chemosensory and mechanosensory pathways recruited overlapping, yet distinct neuronal populations, and elicited distinct variants of the downstream motor pattern. Moreover, simultaneous (bimodal) sensory stimulation was represented by a distinct combination of premotor neurons across the network, but (1) the specific neurons activated were more similar to the mechanosensory condition, and (2) the associated motor output was functionally similar to that of the mechanosensory condition. Thus, despite the lack of a functional difference in truly multimodal conditions, the effect of sensory modality on motor output can be explained by a combinatorial code of premotor neuronal activity.

Information encoding; multisensory; premotor; combinatorial code; rate code; stomatogastric; neuromodulation; sensorimotor