Analysis of salt taste responses in rat cortical neurons by an artificial neural network model

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Summary

Taste qualities are believed to be coded in activity of multiple taste neurons. However, it is not clear whether activity across the entire population of the neurons or across their subgroups is responsible for coding. To clarify the point the relative contribution of each taste neuron to coding needs to be assessed. To this end we constructed simple three-layer neural networks with input units representing cortical taste neurons of the rat. The networks were trained by the back-propagation learning algorithm to classify the neural response patterns to the basic taste stimuli (sucrose, HCl, quinine-hydrochloride and NaCl). The networks had 4 output units representing the basic taste qualities, the values of which provide a measure for similarity of test stimuli (salts, tartaric acid and umami substances) to the basic taste qualities. Trained networks discriminated the response patterns to the test stimuli in a clearer and more definite manner than conventional correlation analysis. We evaluated relative contributions of input units to the taste discrimination of the network by examining their connection weights to the hidden layer. When the input units with weaker connection weights (e.g. 15 out of 39 input units) were "pruned" from the trained network, the ability of the network to discriminate the basic taste qualities as well as other test stimuli was not greatly affected. On the other hand, pruning of only 4 input units with stronger connection weights profoundly deteriorated the taste discrimination of the network. These results suggest that cortical taste neurons differentially contribute to the quality coding. The pruning technique may enable the evaluation of a given taste neuron in terms of its relative contribution to the coding.