Gustatory Responses of Honeybees (Apis mellifera) to Artificial Sweeteners - Behavioral and Electrophysiological Analyses

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Humans and some other animals detect non-nutritive artificial sweeteners (NAS). To elucidate whether honeybees perceive ‘sweetness’ from NAS, NAS (sucralose and acesulfame-K) were given to honeybees and their responses were examined behaviorally and electrophysiologically. Honeybees reflectively extend their proboscis following an application of sucrose solution to taste organs (antenna, foreleg or mouth part). This response, called proboscis extension reflex (PER), allows us to know whether a honeybee ‘feels’ sweetness or not. When bees were harnessed, the rate of PER significantly increased as concentrations of sucrose solution increased, whereas sucralose and acesulfame-K stimulations showed no dose-dependency. Under free-flying conditions, bees repeatedly visited the feeder to drink ‘food’. At the feeder, bees often showed PER (more than 84%) when the feeder dispensed either sucrose, glucose, fructose, or water. In the case of sucralose or acesulfame-K, bees also showed PER but the rate was significantly lower (74% for sucralose, 35% for acesulfame-K) than for any of the sugars and water. This behavioral difference means that honeybees can detect NAS. Extracellular recordings showed the foreleg gustatory sensilla responded to sucralose and acesulfame-K, as well as sucrose and water. These results strongly suggest the presence of a NAS responsive gustatory receptor neuron in the foreleg. These findings will enable a better understanding of the neural mechanisms underlying sweetness perception in the honeybee brain. Additionally, a comparison of the honeybee gustatory neural mechanism for detecting NAS with that of humans and other animals may clarify how sweetness perception and its neural mechanisms have evolved.