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Salty, bitter, sweet and sour survive unscathed

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Abstract
Types of sensory receptor can only be identified by multidimensional discrimination of a familiar version of a sensed object from variants disconfounding putative types. By that criterion, there is as yet no evidence against just the four classic types of gustatory receptor, for sodium salts, alkaloids, sugars and proton donors. 50 words

Comment

Robert P. Erickson uses a feather duster to attack a straw man in a cul-de-sac.

The causal theory of perception is a dead-end

By itself, processing in the brain can never show how many types of taste there are. Philosophers (e.g., Hamlyn 1957) and psychologists (e.g., Gibson 1979) have long pointed out that visual perception cannot be projection onto a cinema screen in occipital cortex. This is a matter of logic, not science: the problem remains how we perceive the picture in that neural firing (even with 'binding' across modules in visual areas). Equally, how does a taster get a taste out of a pattern across fibres? All that can be said from Erickson's account is that one pattern is transformed into another across-fibre pattern until we get to the neuromuscular transmission pattern that produces what speakers of the language have learnt to recognise as a name for a taste.

How we achieve knowledge of the world through the senses is an issue in the first instance of purely psychological science – characterising the unconscious and conscious cognitive processing that accounts for the externally observable performance of the individual. It is sensed materials in items of food and drink (Booth 1994) that are perceived through gustation (Freeman, Richardson, Kendal-Reed & Booth 1993), as for olfaction (Booth. Freeman & Kendal-Reed 1995) and touch (Booth 2005; Richardson-Harman & Booth 2006). So the prior question is how people distinguish sources of tastes. Measurement of the mental causation involved is required in order to work out how the brain processes the signals on which such achievements depend.

Nobody has proposed a single fibre from a tastant receptor to a taste word

Despite caricatures by textbooks and even some neurophysiologists (e.g. Lemon & Smith 2006), a "labelled line" could not have meant a single fibre: the idea was put forward before the cell doctrine was established. The issue is whether any aspect of a human taster's performance can be controlled by a discrete signal from some set of compounds applied to the tongue. Like so many psychophysicists, Erickson is blind to the cultural and cognitive science of sensory description: the design of his experiment fails to measure the way in which the assessor and the investigator "communicate" about reality by saying that a sample tastes

sweet, salty, metallic, savoury or whatever. Even on a simplistic behavioural account, the assessor has to have learned an association between materials containing compounds that stimulate the same type of gustatory receptor and the word that is used to name that set of tastants in the tasted sample. In cognitive reality, the naming of a taste can only succeed in the context of other sensory and conceptual processing, not least the profile of activation of other receptor types that is almost inevitable by any one compound (Booth & Freeman 1993; Booth 1995).

The hypothesis of four basic tastes emerged from 19th century experimental psychologists' exploitation of chemists' recent success in preparing pure compounds, instead of the unknown mixtures available to earlier cultures. Neither Erickson's approach nor the continuing flim-flam about a fifth 'umami' taste (Booth, Konle, Wainwright & Sharpe, submitted) is a cognitive biosocially adequate way to challenge the number four. Definitions of conceptual categories or counts of words do not address the factual question how the compounds control the words. A control group is not the issue either. The problem is proper design of samples to be tasted by any one assessor (Booth, Mobini, Earl & Wainwright 2003).

Taste is not measured by arbitrary calculations from responses to under-designed samples

The experimental results in Erickson's review would be scientifically feather-light, even when reported in full. He asked students to "account for percentages of the taste" of a solution. It is well known that averaging such integrative responses across individuals creates artefacts and that totals of percentage judgments (let alone their group averages) are meaningless. The only treatment of such data that does not make unwarranted assumptions is to compare the largest percentage given by each individual between the same number (four) of criterial and non-criterial compounds. Considering that these are grouped data from an underspecified task, there are remarkable mutual dominances of sucrose and the sweet amino acid, proline, of the two sodium salts, NaCl and MSG, and of the two nitrogenous compounds quinine and ammonium chloride. Unfortunately the only acids used were the 'dirty' tasting HCl, the complex-tasting MSG and the chloride salt of the weak base, ammonia: nevertheless, the taste predominant in HCl uniquely was clearly evident in both MSG and NH_4Cl. Thus the valid interpretation of the data presented by Erickson is support for the classic four types of tastant.

It should also be noted that MSG gave no evidence of being a fifth taste. Rather it reduces to a balance of NaCl-dominated lysine, acids-dominated acetylglycine, sucrose-dominated proline and quinine-dominated phenylalanine, as we have claimed (Freeman *et al.* 1973; Booth *et al.*, submitted).

Erickson does not take account of the only method yet found for identifying discrete types of taste (or of colour, shape, aroma, musical chord, etc.). This is to show that there are ranges of concentrations of different tastants at which discrimination fails, in the general case among mixtures (Booth & Freeman, 1993; Booth *et al*. 1995, 2003) or in the special case of two or more single compounds of the same type (Breslin *et al*., 1996). The concentrations do not need to be matched empirically: it is much more efficient to estimate the indiscriminable ratio(s) by interpolation, using the determinate calculation of multi-psychophysical discrimination distances from the internal standard (Booth & Freeman, 1993; Booth *et al*., submitted). Until Erickson's tastants are tested this way, there are no perceptual data by which to evaluate the molecular evidence for gustatory receptor types on the human tongue and to start tracking multiple-fibre codes around the brain.

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