

stimulations with a light flash is accurately reproduced by the shape of the averaged evoked potential (average of 150 sweeps) recorded from the same microelectrode. Since these distributions are simply counts of single-cell spikes from 4918 or 3150 multiple superimposed sweeps, little or no indication of such distribution is ever seen in single traces or in a few superimposed traces.

Overall correlations (total sweep) of single-cell spike distributions with their respective evoked potential waveforms yielded significant correlation coefficients for 66 percent of the pairs. Correlation coefficients ranged from 0.14 to 0.88 with 58 percent significant at the .001 level, 6 percent at the .01 level, and 2 percent at the .05 level of probability.

Components of the evoked response in which there are deflections both negative and positive to the baseline are duplicated by a single-cell frequency distribution only if the spontaneous firing rate is greater than zero. The relation described here between the probability of firing of a single cell and the waveform of the evoked potential holds in general for responses of single cells to both visual and somatic stimuli recorded from a number of sensory and association cortical areas, for the cerebellar vermis, and for responses of single cells to two sensory stimuli separated by a short interval. That is, if a cell responds to more than one sensory stimulus, the probability of response to each stimulus is given by the respective waveform of the evoked potential.

We conclude from these data that no component (positive or negative, early or late) of the asynchronous evoked potential recorded in this way is uniquely related to responses of specific cell populations or to specific portions of cells, since from each cell a probability curve can be obtained which closely resembles the waveform of the entire evoked response. This outcome suggests, therefore, that whatever potential sources contribute to the evoked potential, they are directly related to or reflected in the firing of a single cell.

The data appear to support at least

two interpretations of evoked potential electrogenesis: (i) the evoked potential may consist of summated and asynchronous discharges from cell bodies, with cells in a given localized area having approximately the same probability of firing, or (ii) the evoked potential may be compounded of electrical activity from a number of sources either local or distant, for example, apical, somatic, or basal dendritic postsynaptic potentials and local potentials associated with electronic spread from dendrites.

Although our records for both cells and waves are from microelectrodes deep in the cortex, some more specific conclusions can be drawn. It appears, for example, that either the recorded evoked potentials do not reflect dendritic activity at all and that both positive and negative waves recorded are local in origin, or that there is, in fact, an important relation between dendritic activity and the production of spikes from the cell body.

Whatever mechanisms actually underlie the observed correlation between probability of firing of single cells and the waveform of the evoked potential, it is certain that, contrary to conclusions from other studies (4), knowledge of the waveform of the evoked potential does, to a great extent, enable prediction of the response pattern of a particular cortical cell.

STEPHEN S. FOX

JAMES H. O'BRIEN

*Department of Psychology and  
Mental Health Research Institute,  
University of Michigan, Ann Arbor*

#### References and Notes

1. G. H. Bishop and M. H. Clare, *J. Neurophysiol.* **15**, 201 (1952); *ibid.* **16**, 418 (1953); C. L. Li, C. Cullen, H. Jasper, *ibid.* **19**, 111 (1956); C. L. Li, *J. Cell. Comp. Physiol.* **61**, 165 (1963); L. Widen and C. Ajmone-Marsan, *Arch. Ital. Biol.* **98**, 248 (1960); D. P. Purpura and H. Grundfest, *J. Neurophysiol.* **19**, 573 (1956); H. Grundfest, *Electroencephalog. Clin. Neurophysiol. Suppl.* **10**, 22 (1958); *N.Y. Acad. Sci.* **92**, 877 (1961); D. P. Purpura and R. J. Shofer, *J. Neurophysiol.* **27**, 117 (1964); ———, F. S. Musgrave, *ibid.* **27**, 133 (1964).
2. Mnemotron Computer of Average Transients, model 400-B.
3. Digital Equipment Corporation, PDP-1.
4. R. Jung, *Electroencephalog. Clin. Neurophysiol. Suppl.* **4**, 57 (1953); G. L. Gerstein and N. Y.-S. Kiang, *Exptl. Neurol.* **10**, 1 (1964).
5. This research was supported by NSF grants G21446 and GB1711.

15 December 1964

## Duplexity Theory of Taste

It has been unfortunate for the study of the neural bases and psychophysics of the chemical senses that the underlying physical continua are unknown; there is no wavelength or frequency for taste and smell. Consequently, most studies of taste, psychophysical and neural, are based on its four psychophysical "primaries," sweet, sour, bitter, and salty. These four primaries have never been too convincing, as is evidenced by von Békésy's recent psychophysical "duplexity" theory of taste (1), in which bitter and sweet are grouped together with warm as one factor, and salty and sour with cold as the other. These relationships were chosen on the basis of the interactions within each group and lack of interaction between groups.

Recently it has been shown that the neural basis of taste involves many fiber types rather than two or the classic four (2). Since von Békésy intends to refer his data to physiological mechanisms, perhaps the relation of these two sets of data should be discussed. The neural argument (2) concluded that the neural basis of taste is much like audition in that there are no "primaries," but that there are many fiber types ranging along the stimulus continuum.

Thus, an investigator choosing stimuli in either taste or audition, if he did not know the relevant stimulus continua, might choose two groups of stimuli with large intragroup interactions and small or nonexistent intergroup interactions. Clearly it would be improper to derive from this a two-factor theory for audition. The proper procedure in both modalities would involve either the use of more stimuli or the discovery of the continuum.

ROBERT P. ERICKSON

*Department of Psychology,  
Duke University,  
Durham, North Carolina*

#### References

1. G. von Békésy, *Science* **145**, 834 (1964).
2. R. P. Erickson, in *Olfaction and Taste*, Y. Zotterman, Ed. (Pergamon, New York, 1963), pp. 205-213.

8 January 1965

## Duplexity Theory of Taste

Robert P. Erickson

*Science* **147** (3660), 890.  
DOI: 10.1126/science.147.3660.890

ARTICLE TOOLS <http://science.sciencemag.org/content/147/3660/890>

REFERENCES This article cites 1 articles, 1 of which you can access for free  
<http://science.sciencemag.org/content/147/3660/890#BIBL>

PERMISSIONS <http://www.sciencemag.org/help/reprints-and-permissions>

Use of this article is subject to the [Terms of Service](#)

---

*Science* (print ISSN 0036-8075; online ISSN 1095-9203) is published by the American Association for the Advancement of Science, 1200 New York Avenue NW, Washington, DC 20005. 2017 © The Authors, some rights reserved; exclusive licensee American Association for the Advancement of Science. No claim to original U.S. Government Works. The title *Science* is a registered trademark of AAAS.