Differentiation of Differing Concentrations of Sucrose and Glucose by Human Newborns

Nowlis and Kessen (*1*) observed that "There is a remarkable similarity in slope and in relative height between the psychophysical functions and those implicit in the four data points from the infant tongue pressure responses."

Two criticisms of such a facile deduction need to be expressed. First, on looking at the graph which underlies the statement quoted [figure 2 in (*1*)], it is immediately apparent that an exponential function (tongue pressure–log concentration) is being compared to a log-log (psychophysical) function. This is like comparing oranges and tangerines, or cod and hake. Second, two points on a curve tell us nothing about its shape or slope, regardless of the method of scaling.

I do not want these comments to detract from the two general conclusions reached by the investigators: that the newborn has a competent sensory apparatus for assessing relative sweetness, and that it is capable of systematically eliciting a precisely graded response. Both of these valuable conclusions derive from the data. It might be noted here that the numerical data given are contained only in the graph. This shortcut may make for ease of presentation, but some precision is lost.

Further on in their report, Nowlis and Kessen speculate on the reason for differences in slope between these data and the results reported by Maller and Desor (*2*). I would suggest that the mathematics of curve presentation be reviewed, so that "apparent" discrepancies are not fictitious.

N. W. Bolduan
Institute of Environmental Stress, University of California, Santa Barbara

References

1. G. H. Nowlis and W. Kessen, *Science* **191**, 865 (1976).
2. O. Maller and J. O. Desor, in *Fourth Symposium on Oral Secretion and Perception*, Bethesda, Md., J. F. Bosma, Ed. [HEW Publ. No. (NIH) 73-546 (1973)].

12 March 1976

Bolduan has concluded that we have compared an exponential function with what he calls a "log-log function." There are two inaccuracies in this conclusion. First, although we did present our data points in a coordinate system with a logarithmic abscissa and an arithmetic ordinate, there were only two of these data points per "function," and hence not enough information to conclude, as Bolduan has, what type of function describes our data. Any function may be drawn in such coordinates; the heuristic value of such a coordinate system for the plotting of an exponential function is minimal (*1*). Second, the term "log-log function" does not adequately describe any relationship between two variables. Psychophysical relationships are traditionally presented in log-log *coordinate systems* because it now appears that for any sensory modality the empirical relation between stimulus intensity and sensation magnitude is a *power* function (*2*), and because in log-log coordinates a power function describes a straight line.

Although we should like to think of our work as a first step toward developing a psychophysics of taste sensation in the newborn, we intended to avoid creating any impression that we felt such a development had been achieved. Thus, we decided not to present our data in the traditional log-log coordinates, to make very explicit in the text the way in which we devised the scale, to make the scale in the figure extremely simple and obviously nonlogarithmic, to present our data only as points in the figure, and not to connect these points with any lines which might suggest that we interpreted our data as a function. Finally, we added the caution, in the sentence following that which Bolduan quotes, that "Future work, of course, must include more than two concentrations of each sugar to determine more precisely the slope of the concentration function in the newborn." In short, we attempted to make it clear that our comparison, although highly suggestive, was at this stage a comparison of things interestingly similar, but importantly dissimilar (like oranges and tangerines or cod and hake).

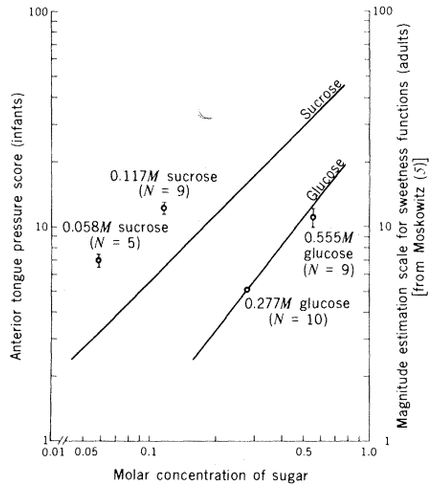

Fig. 1. The four data points are tongue pressure scores (left ordinate) for the four sugar solutions given to infants (*3*). Standard errors are indicated by vertical bars. The two lines are psychophysical functions (right ordinate) for adults, from Moskowitz (*5*).

We had in fact made an exploratory charting of our four data points in log-log coordinates, with appropriate apposition (*3*) to the adult psychophysical functions (Fig. 1, herein). Despite the tantalizing congruities, we chose to publish our data as described above in order to avoid any suggestion that at this stage our infant data fit a power function. We intended our comparison only to lead to recognition of sufficient grounds to pursue the further research needed to identify explicitly the functions that are only suggested in our data. The sense in which we used the word "implicit" in the sentence quoted by Bolduan is that of Webster's (*4*) definition **2 a** (2): "involved in the nature or essence of something though not revealed, expressed, or developed : POTENTIAL ⟨ the oak is [implicit] in the acorn⟩ . . . ."

Geoffrey H. Nowlis
Rockefeller University, New York 10021
William Kessen
Department of Psychology, Yale University, New Haven, Connecticut

References and Notes

1. *Logarithmic* functions are often presented in such coordinates, where they describe a straight line; *exponential* functions, which generally yield a sharply curved graph in such a coordinate system, are rectified to a straight line with an arithmetic *abscissa* and a logarithmic *ordinate*.
2. S. S. Stevens, *Science* **170**, 1043 (1970).
3. Our infant tongue pressure scores [G. H. Nowlis and W. Kessen, *Science* **191**, 865 (1976)] were derived by taking the mean amplitude of the strongest ten sucks to a given concentration, and dividing that by the mean amplitude of the strongest ten sucks to the standard glucose concentration (0.277*M*) for that infant. This yielded a score of 1.0 for the standard glucose for all infants; the means and standard errors for the other three stimuli were: 0.058*M* sucrose, 1.37 ± 0.10; 0.117*M* sucrose, 2.38 ± 0.16; 0.555*M* glucose, 2.16 ± 0.21. These values were then multiplied by 5.08, which matched the value for our standard glucose to the magnitude estimate score for that concentration of glucose yielded by Moskowitz's equation for glucose (*5*). Of the nine slightly differing equations for the sweetness of glucose, we chose for the present Fig. 1 the equation derived in the same experiment (IV) from which was derived the sole equation for the sweetness of sucrose. Since it was not clear from which of these nine equations the psychophysical graph for glucose sweetness was derived, we chose for our original report to draw the function graphs in figure 2 directly from Moskowitz's figures, a potentially less accurate technique than the present one. The slight discrepancies clearly do not modify our conclusions.
4. *Webster's Third New International Dictionary of the English Language, Unabridged* (Merriam, Springfield, Mass., 1961).

→ H. R. Moskowitz, *Am. J. Psychol.* **84**, 387 (1971).

2 August 1976