STUDIES IN HUMAN INHERITANCE XV

The Bimodality of the Threshold Curve for the Taste of Phenyl-thio-carbamide

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It has been shown by Snyder (1931, 1932), and Blakeslee and Salmon (1932) that the taste deficiency for phenyl-thio-carbamide (P. T. C.) is inherited as an autosomal recessive. Later Blakeslee (1932) showed that a wide variation exists in acuity of taste discrimination for the substance. He pointed out that persons who are non-tasters of the crystals can taste a saturated solution. The thresholds of those who are tasters of the crystals cover a wide range of dilutions.

It becomes important to determine whether the curve of thresholds involving both tasters and non-tasters of the crystals is actually bimodal. Do tasters and non-tasters represent one variable population, or can they be accurately separated on the basis of threshold tests?

To determine this point 584 persons were carefully tested for threshold. Of these 477 were white individuals and 107 were negroes. Of the whites, 85 were non-tasters of the crystals, while of the negroes only 8 were non-tasters.

For the thresholds tests a stock solution was made by dissolving .1 gram of P. T. C. in 99.9 cc. of distilled water. Since P. T. C. is only .26% soluble in water, this stock solution was allowed to stand overnight or was heated to 45° C. to obtain complete dissolution before it was used. From this solution dilutions were made ranging from .01% to .00001%. This range of dilutions was satisfactory for determining the thresholds of the tasters.

The solutions used for testing the non-tasters were made from a stock solution of 1.0% containing 40% alcohol, which was found to be the best solvent in addition to water. Alcohol of a strength comparable to that used in the P. T. C. solutions was used to check all non-tasting subjects, so that they would not confuse the taste of the alcohol with the taste of P. T. C.

A beaker of distilled water was given to each subject before testing so that he might rinse his mouth and become acquainted with the taste of distilled water. He was also asked to rinse his mouth immediately after noting the taste of each solution given. The solutions were placed on the back of the tongue of the subject by means of long pipettes. The weakest solutions were given first to avoid over-stimulation of those who had low thresholds. A number of trials on solutions near the threshold of the subject were made and that concentration which gave a bitter taste in half of the trials made was considered the threshold. Some subjects, however, could always discriminate between one concentration and the next strongest one.

In considering the distribution of tasters and non-tasters among the white group and among the negroes, the frequencies are obviously disproportionate, and the two racial groups must therefore be considered separately. This conclusion is based on the X^2 (Chi square) value of 6.983. The corresponding probability lies beyond the .01 limits and must be taken as indicative of uncontrollable differences between the two racial groups.

The X^2 test as used here, and also in the statements following where male and female groups are compared, takes the form:

$$X^2 = \frac{\frac{\Sigma I}{\Sigma D}\left[\Sigma I\left(\Sigma \frac{D^2}{I}\right) - \left(\Sigma D\right)^2\right]}{\Sigma I - \Sigma D}$$

Here I equals the total in any sub-group and D equals the number of non-tasters in the sub-group. The degrees of freedom for checking the probability in tables of X^2 are always one less than the number of sub-samples.

The frequencies of tasters and non-tasters among the white males and females are proportionately homogenous by the above mentioned technique. There were 251 tasters and 61 non-tasters among the males, and 141 tasters and 24 non-tasters among the females. The probability for homogenity is approximately .20. Thus no division on the basis of sex can be made.

Table I gives the frequencies of tasters and non-tasters among the white and negro groups. In following the distribution through the table it will be noted that in general the frequencies give a bi-modal grouping of thresholds in regard to concentration. One mode appears among the tasters of crystals

TABLE I

FREQUENCIES OF TASTERS AND NON-TASTERS AMONG WHITE AND NEGRO GROUPS WITH THE SCALE OF DILUTIONS OF P. T. C. GIVEN IN FRACTIONS OF 1% SOLUTION

Fraction of 1% P. T. C. Solution	Number of White Individuals	Number of Negro Individuals	
Less than .00001	13	3	
.00001	18	7	
.00002	11	2	
.00003	3	1	
.00004	4	4	
.00005	7	2	
.00006	10	4	
.00007	4	3	
.00008	11	1	
.00009	25	3	
.0001	32	7	
.0002	55	9	
.0003	46	21	
.0004	36	10	Tasters of crystals
.0005	20	3	
.0006	14	2	
.0007	22	1	
.0008	9	3	
.0009	13	5	
.001	19	2	
.002	7	2	
.003	2	1	
.004	4	2	
.005	1	0	
.006	2	0	
.007	1	1	
.008	1	0	
.009	1	0	
.01	2	2	
.02	1	0	
.03	0	1	
.04	4	0	
.05	2	0	
.06	0	0	
.07	1	0	
.08	0	0	
.09	2	0	
.1	18	1	Non-taster of crystals
.2	20	0	
.3	14	2	
.4	3	0	
.5	4	0	
.6	1	0	
.7	0	0	
.8	0	0	
.9	2	0	
1.0	12	2	

and one modal group among the non-tasters. The continuous occurrance of individuals tasting the solutions throughout the series of dilutions would suggest that there are modifying factors that are operating on the postulated simple pair of allelomorphs that determine the major segregation of the groups in either the tests with crystals or with the P. T. C. in solution. Another interesting feature is that some individuals in the one extreme of the tabulation could detect minute traces of the substance, less than .00001 of 1%. In the other extreme some individuals listed in the class of 1% could taste only heated solutions of which the true concentration was not determined.

It should be noted in the tabulation that the intervals of dilutions are not in unit steps. This, however, need not invalidate the description of the two general groups in terms of their means and standard errors. This frequency if plotted on an arithmetic scale would give the appearance of a heavily skewed sample, but the bi-modality would not be changed. The mean threshold of the 392 taster individuals among the white group falls at .00050 with a standard error of .000064, while the mean threshold of the 85 non-tasters falls at the .33341 level in the solutions with a standard error of .002425. The mean difference is .33291 with its standard error of .03315. The ratio of this difference to its standard error is then 10.04, and the two groups as differentiated bi-modally have an exceedingly small probability of having been drawn from a homogenous population with respect to thresholds of taste.

Among the negro group the 99 tasters of crystals show a mean threshold at the .00049 level of dilution. The mean threshold for the 8 non-tasters falls at the .3437 level of dilution. These means are proportionally equivalent to the means of the white group and can be taken as indicative of the true separation of tasters and non-tasters on the basis of threshold.

The results of the above tests show that testing by solution of different concentrations of P. T. C. distinguishes tasters from non-tasters as does testing with the crystals. The variation in thresholds show that extreme differences exist between individuals. This point is entirely lost when testing only with the crystals. Although the variation in threshold seems to indicate that modifying factors are effecting the reactions of taste, the data as a whole bear out the conclusion that lack of ability to taste crystals depends on a simple recessive factor. The quantitative treatment made possible by the threshold tests bring out the reactions of taste as a variable physiological phenomenon in line with genetic behavior.

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