

30th January 1934.

Dr. Whately Carrington,  
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Holland.

Dear Dr. Whately Carrington,

I am sorry to have kept your data so long, but one thing after another has delayed me. In order not to make it longer I have now finished the analysis on 50 words, that is, from those available from your numbers 1 to 53.

From the 10 totals for all words there are 9 degrees of freedom, one for personality, the mere contrast of Garrett versus Uvani, 4 for the differences between occasional <sup>and</sup> personality, or essentially the variation among the 5 differences Garrett minus Uvani.

The system of giving each reaction time as a percentage of the average for all words for the same personality on the same occasion practically wipes out all differences among the totals of these ten columns.

Thus from 250 readings for Garrett I have a total 24890, and for Uvani 25202. The difference is 132, and this squared and divided by 500 gives 35 as the

sum of squares for the one degree of freedom for personality. The 4 degrees of freedom for occasion likewise scores 1321, this being calculated as follows.

The sum of a hundred observations for the first occasion gives 1231, and for the other occasions 9757, 9843, 10009, 1181. Their mean is 9982.4. One takes the sum of the squares of the deviations from the mean and divide-by 100, the number of entries in each total used. This gives 1321.

Similarly the differences Garrett minus Uvani on the 5 occasions are -119 -95 -315 -58 +455. The sum of the squares of the deviations of these from their mean divided by 100 gives 3293 for interaction of occasion with personality. All these three entries have of course been reduced to sub-normal values by using the percentage method, and would have been reduced to zero had the percentages been based on just the 50 words which I have used. There is, I think, therefore nothing to be learned from these three values, except the method of procedure, which is exactly similar to that which I have applied to the scores for individual words in obtaining the 49 degrees of freedom for pxw. The 196 degrees of freedom for oxw and the 196 for oxpxw.

For each word we have a total score for the ten readings and the variation among these 50 totals

represents that portion of the variance due to different reactions to different words irrespective of personality or occasion. The average of these totals is 998.24 and the sum of the squares of the deviation from this average divided by ten gives 119112 contributed to the sum of squares by these 49 degrees of freedom. If for each word we sum the 5 occasions for Garrett and subtract the 5 occasions for Uvani, we have 50 differences representing the difference in reaction of the two personalities to two different words. The average of these is -2.64 and the sum of the squares of their differences from their averages divided by ten gives 95730 as the amount contributed to the sum of the squares by the 49 degrees of freedom pxw. This is not much less than the amount contributed by words alone showing that the difference between the reactions of the two personalities is not much less variable than the sum, or in other words, that there is little similarity between them in their reactions to different words. A critical conclusion, however, is only possible by considering the consistency of these different reactions on different occasions.

For each word, therefore, I have taken the 5 totals (G+U) for 5 occasions squared their differences from their mean and divided by 2. Likewise I have taken

the 5 differences G-U squared their differences from their mean and divided by 2. These processes give for each word 4 degrees of freedom, the first lot corresponding to the way in which occasions was obtained from the totals, and the second lot to the way in which the interactions of occasions and personality was obtained. Adding up the first column for 50 words we have 200 degrees of freedom making a total contribution of 160018.2, the 4 degrees of freedom for occasions has evidently been included in this total so that if we subtract 1321 we shall have left 158697 contributed by the 196 degrees of freedom for  $oxw\frac{1}{2}$ . Proceeding similarly I obtained 169428 for the 196 degrees of freedom  $oxpxw$ .

This last entry should theoretically represent error, that is discrepancies on different occasions between the differential response of the two personalities to the 50 words. Dividing the sum of squares by 196 we have the mean square 864.4, or a standard deviation of between 29 and 30 units in the original data. Probably this is not unexpectedly large. The mean square for  $oxw$  is smaller 809.7 but not significantly so. Possibly these both represent nothing but experimental error which is in any case well determined from 196 degrees of freedom. The mean square for  $pxw$  is 1953.7 considerably greater than that describable to error showing a very significant difference

between the personalities in their reaction to different words. There can I think, be no doubt whatever as to the reality of this effect, and a list of words could doubtless be picked out for which Garrett gave a longer reaction time than Uvani and visa versa, these differences being confirmed in a succession of independent trials.

The absence of any apparent interaction between occasions and words is a striking and perhaps an important feature of the data. One would, I think, have expected a priori that differences in the physiological condition of the medium on different occasions might induce a change in the reaction to some words affecting both personalities in the same direction, and this would show by  $o_{xw}$  exceeding  $o_{pxw}$  on the average. Either this effect is absent, or it has been masked by something else. The remaining words on the list should serve to confirm whether  $o_{pxw}$  really has a larger mean square than  $o_{xw}$  and perhaps putting the two portions of the data together the difference might be statistically significant. What the interpretation should be it is difficult to say, one could scarcely expect ordinary variations in the physiological condition of the medium to induce variations in reaction in opposite directions in the two personalities, unless she were sub-consciously striving to make their emotional responses as unlike as possible so that when

to the same word Garrett reacts with an unusually long reaction time this fact should itself cause Uvani to give a shorter reaction time than usual.

However, psychological interpretation will be your business, and I shall have done mine if you understand clearly into what portions the variants among the observed times is capable of being divided, and how this is actually done in arithmetical practise.

Yours sincerely,