

CONTRIBUTION TO A DISCUSSION OF F. YATES'
PAPER ON COMPLEX EXPERIMENTS*

(incomplete extract)

- * Yates, F. (1935) Complex experiments. *Journal of the Royal Statistical Society, Supplement*, 2: 181-223.

PROFESSOR FISHER said

he was particularly glad that the author had emphasized the rather subtle point which was sometimes a cause of confusion, namely, that what they chose to call interaction represented a relationship in their own minds, and another might regard it as a main effect. That fact of choosing for one's own convenience affected not only the terms applied, but the structure of the experiment made; that was particularly well emphasized by the process of confounding and partial confounding to which Mr. Yates had made such notable contributions. The whole art of confounding lay in the choice of particular interactions, which were of little or no experimental interest, with a view to enhancing the precision of certain other comparisons which by one's own particular choice were thought to be more important. The value of partial confounding lay in the fact that by spreading the loss of information over the whole group of interactions of lesser interest, it was possible to recover any points which were of actual interest in that mass of comparisons which one was prepared to throw away. Particularly Mr. Yates was to be congratulated on the new data on block sizes, and the practical efficiency of the various methods of examining them.

At that late hour Professor Fisher only wished to add one more point which was often helpful to those who found the arrangement of these large experiments complex, not only in the technical but in the practical sense. There were two aspects of an experiment which could be considered: one was the topographical structure of the experiment as it existed in the field, consisting perhaps of plots within blocks, or sub-plots within plots. Thus, in a 5×5 Latin square with plots subdivided each into two, one could recognize, quite apart from any question of what treatments were to be used or how they were to be arranged, that the 49 degrees of freedom available must be divisible into the portions set out below:

	{	Rows	4
Between Plots		Columns	4
		Remainder	16
Within Plots		.. .. .	25
			—
Total		.. .. .	49
			—

This analysis was entirely topographical. If, then, an experiment consisted of a comparison of five treatments of one kind, and two treatments of a second kind, making ten combinations in all,

each to be replicated five times, the structure of the experiment, ignoring all topographical considerations, would take the form :

First Factor	..	..	..	..	..	4
Second Factor	..	..	..	..	..	1
Interaction	..	..	..	..	..	4
Parallels	..	..	..	..	..	40
						49

The choice of the experimental design might be regarded as the choice of which items in the first analysis were to correspond to any chosen items in the second, and this could be represented by a two-way analysis of the 49 elements. Thus, the decision to eliminate differences between the rows and columns of the square from the treatment comparisons was the choice that the eight degrees of freedom corresponding to the rows and columns in the first analysis shall come from the 40 degrees of freedom shown as parallels in the second analysis.

The choice that the first treatments should occupy whole plots of the square which should be subdivided for second treatments, was the choice that, of the 16 degrees of freedom between plots, 4 should be allotted to the first treatments, and the remaining 12 would supply the experimental error for these comparisons. The remaining 5 degrees of freedom for second treatments and interaction must therefore be assigned to the 25 degrees of freedom within plots, of which the remainder would supply the appropriate error. The design might therefore be represented by a particular two-way distribution :

Topographical.					
	Rows.	Columns.	Between Plots.	Within Plots.	Totals.
1st Factor..	—	—	4	—	4
2nd Factor	—	—	—	1	1
Interaction	—	—	—	4	4
Parallels ..	4	4	12	20	40
Totals ..	4	4	16	25	49

as shown in the two-way table.

In the semi-Latin square of types other than the Latin square with split plots, the treatment components which we were interested in examining separately were not assignable to distinct elements of the topographical analysis, and every such comparison would have a different error, which it would be exceedingly laborious to estimate.