International Statistical Review (2008), 76, 1, 134–139 doi:10.1111/j.1751-5823.2007.00022.x

Letter to the Editors

What is the Mixed-Models Controversy?

From: John A. Nelder

Imperial College, London, UK

Two papers have recently been published in this journal which purport to deal with the mixed-models controversy (Lencina *et al.*, 2005; Lencina & Singer, 2006, to be referred to as L1 and L2). In my view they do not represent the current state of thinking on this subject. My own work begins with Nelder (1977) and continues with papers in 1982, and particularly with Nelder (1994, 1995). Further papers are Nelder (1997), whose title includes the phrase 'The great mixed-model muddle', and Nelder (1998). In Nelder (1994) I describe what I regard as three false steps that have generated confusion and show how a consistent treatment may be developed. The two most important ideas are (1) marginality relations between terms in a factorial model, and (2) why constraints must not be put on parameters because they are required on estimates.

1 Marginality

Consider a simple model with two classifying factors A and B. The terms in the full factorial model are 1, A, B and A.B where 1 represents the grand mean. These terms are ordered by their marginality relations; A and B are subspaces of the two-way table of effects A.B and 1 is a subspace of both A and B. We say that 1 is marginal to A and B and both A and B are marginal to A.B. If a model is going to make statistical sense it must respect the marginality relations between the terms, meaning that any term must be preceded by the terms that are marginal to it . Thus 1+A, 1+B, 1 +A+B, 1+A+B+A.B satisfy these conditions but 1+A+A.B does not. This last model implies that the two-way table of effects A.B, which, whether fixed or random, can be completely arbitrary, nonetheless is to have a null margin showing no variation. The probability of this is zero, and hence I contend that this model, though expressible mathematically, makes no statistical sense. These models correspond to statistically uninteresting hypotheses; the fact that they are mathematically expressible does not imply that they make statistical sense. Note that Type III and IV sums of squares in SAS break these marginality rules, and even Scheffé (1959) comes unstuck here.

2 Constraints on Parameters

Every one agrees that estimates of parameters in factorials obtained by least squares will need to be constrained if we are to obtain unique values for them. Thus it is common in the example above to set the sums of the A and B effects to be zero and also the row and column totals for the interaction A.B. The possible constraints are not unique, and any contrast given a value by this procedure is said to be *estimable*. Thus the following are not estimable whatever set of valid