PATTERNS IN CORRELATION MATRICES ARISING IN WINE-TASTING AND OTHER EXPERIMENTS

by

Christopher J. Brien
B. Sc. Agric. (Sydney)

Thesis submitted for the Degree of Master of Agricultural Science

in The University of Adelaide,
Biometry Section.

May, 1980

CONTENTS

SUMMARY

There are two distinct areas of research on which the work in this thesis impinges. They are methods for the analysis of patterns in correlation matrices and the analysis of taster performance in wine-tasting experiments in which the wines are scored.

For the analysis of patterns in correlation matrices, least squares procedures are developed to examine patterns under certain equal correlation hypotheses. The procedures are applied to the z-transforms of the elements of correlation matrices that can be based on either a single group of variables, or variables that can be cross-indexed by two factors such as the multitrait-multimethod matrices given by Campbell and Fiske (1959). The procedures are of the analysis of variance type, being investigative in the sense that, in the event that the correlation matrix is judged to depart from the hypothesised pattern, alternative models to be pursued further are indicated. The associated statistics are calculated directly from closed-form expressions, rather than requiring the iterative solution of some estimation function as is the case with some alternative methods.

The procedures are used to analyse the data from a number of wine-tasting and other experiments. The results obtained are shown to be similar, in many instances, to those obtained with maximum likelihood procedures applied to variance-covariance matrices; in other instances, large differences occur between the methods. The test for the hypothesis of equal correlation between all variables developed here is also shown to give similar answers to Lawley's (1963) test for the same hypothesis, in a number of cases.

For the analysis of taster performance in wine-tasting experiments in which the wines are scored, the method of examining patterns in correlation matrices can be applied to multitaster and multitaster-multisession

correlation matrices. Certain conditions to be fulfilled by multitaster-multisession matrices are specified; the extent to which they are met in a particular experiment can be ascertained from the results of these analyses. The data from several wine-tasting experiments are analysed and the results provide further substantive evidence of the lack of agreement and differences in reliability that can occur between tasters in such experiments.

As the technique is applied to data from a single experiment, it can be used, particularly when session replicates are included, to select tasters on the basis of their performance in the experiment under consideration - a highly desirable approach. Four duplicate-evaluation wine-tasting experiments, that were aimed at determining the effect of several treatments on wine quality, fit into this category and so are analysed in more detail. A group of less heterogeneous tasters is selected, where possible, for each of the experiments using the results of the analysis of the multitaster-multisession correlation matrices.

Compared with other techniques for selecting tasters on the basis of their results in a wine-tasting experiment, the analysis of multitaster-multisession correlation matrices has the advantages that both reliability and agreement are measured and that the measures are correlation coefficients.

However, even the subsets of selected tasters do not behave in a manner that would justify a single analysis for mean differences for each subset. Because this is likely to be a common phenomenon, it is recommended that wine-tasting experiments be designed to include session replicates and the scores of each taster be analysed for mean differences separately. The results of the analysis of the multitaster-multisession matrix can then be used to determine the confidence to be attached to the results of individual tasters in drawing inferences from the experiment.

SIGNED STATEMENT

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university and, to the best of my knowledge and belief, the thesis contains no material previously published or written by another person, except when due reference is made in the text of the thesis.

C.J. Brien

ACKNOWLEDGEMENTS

It is with much appreciation that I acknowledge the guidance and assistance that I received from Professor A.T. James and Drs O. Mayo and W.N. Venables. In particular, Professor A.T. James suggested the approach taken in Chapters 3 and 4.

I am grateful to Dr P. May for providing me with the original problem, for encouraging me to undertake a higher degree and for his indulgence while I carried out the work.

The work was begun while I was employed by the CSIRO Division of Horticultural Research and completed after I moved to Roseworthy Agricultural College. I thank these institutions for their support.

I am greatly indebted to Mrs H.M. Simpson who performed the demanding task of typing the majority of this manuscript. I also wish to thank Mrs B. Adlard who typed appendices D-H.

Messrs D. Armstrong, J. Brown, A. Hoey, A. Hood, P. John, G. Kerridge, N. Lindsay, R. Moody, G. Prass, M. Tummel, B. Tyson, C. Weeks and P. Weste played a vital role in the work presented in this thesis. They were the tasters in the four wine-tasting experiments described in section 2.3.

Finally, I thank Ellen, Jamie and Melissa who gave up more than they might have so that I could do this work.