

6.1 Overview - Allow heterogeneity

An important assumption of classical analysis of variance (ANOVA) is that the errors come from a distribution with a common variance. By this we assume, in essence, that the variability of the sampling units within each group is constant and equivalent across all of the groups. Similarly, for multivariate dissimilarity-based tests, such as PERMANOVA ([Anderson \(2001\)](#)), we generally wish to assume that the dispersion (spread) of the sampling units in the space of the chosen resemblance measure is consistent across the groups. A PERMDISP test may be used to ascertain homogeneity of multivariate dispersions formally ([Anderson \(2006\)](#)). In the absence of heterogeneous dispersions, any significant result that may arise from our PERMANOVA test can be attributed to a shift in centroid. The effects of heterogeneity of multivariate dispersions on inferences in PERMANOVA tests were found only to be of some consequence in the case of unbalanced designs, and these effects were nowhere near as dramatic for PERMANOVA as they were for ANOSIM or Mantel tests ([Anderson & Walsh \(2013\)](#)).

[Anderson et al. \(2017\)](#) have provided a modification to the original PERMANOVA pseudo F test statistic that *allows heterogeneity of dispersions*. The new PERMANOVA routine in PRIMER 8 can be used to implement this technique, permitting the end-user to make direct inferences regarding differences in centroids, while taking into account known heterogeneity in dispersions, where present.

This chapter begins with a short description of ANOVA and the Behrens-Fisher problem (BFP) for univariate cases, then describes the BFP for multivariate situations. The solution to the multivariate BFP provided by [Anderson et al. \(2017\)](#) is then given, and we step through a one-way example. Complications that arise when we move to consider more than one factor in multi-way ANOVA designs are then discussed. We then step logically through a two-way example to clarify these ideas, outlining appropriate tests and associated graphics in a case study.

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