Testing for activation in FMRI block-design experiments

Martina Pavlicová
Noel Cressie
Thomas J. Santner
The Ohio State University

Abstract

The traditional method for processing functional magnetic resonance imaging (FMRI) data is based on a voxel-wise, general linear model. For experiments conducted using a block design, where periods of activation are interspersed with periods of rest, a haemodynamic response function (HRF) is convolved with the design function and, for each voxel, the convolution is regressed on prewhitened data. An initial analysis of the data often involves computing voxel-wise two-sample t-tests, which avoids a direct specification of the HRF. Assuming only the length of the haemodynamic delay is known, scans acquired in transition periods between activation and rest are omitted, and the two-sample t-test is used to compare mean levels during activation versus mean levels during rest. However, the validity of the two-sample t-test is based on the assumption that the data are Gaussian with equal variances. In this article, we propose use of modified versions of the classical t-test that correct for departures from these assumptions. The relative performance of the tests are assessed by applying them to simulated data and comparing their size and power; one of the modified tests (the CW test) is shown to be superior.