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x^2 = \frac{1}{2} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^3 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^4 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^3 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^3 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^3 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^3 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^3 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^3 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^3 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^3 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\frac{1}{4} \right] x^3 + \frac{1}{4} \left[\frac{1}{4} \right] x^2 + \frac{1}{4} \left[\
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4\overline{1}ms\overline{1}^{2},\quad 4\overline{1}^{3},\quad 4\overline{1}^{1},\quad 1^{1},\quad 1^{1},\quad 4^{2},\quad 4^{3},\quad 4^{3},\quad 4^{2},\quad 4^{3},\quad 4^{3},\quad
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ABSTRACT

 T_{max} paper reviews and compares the compares thresholding methods for instance $\frac{1}{2}$ and $\frac{1}{2}$ active voxels in single $s_{\phi} = \frac{1}{2} \sum_{i=1}^{n} \left[\sum_{i=1}^{n} \sum_{j=1}^{n} \hat{p}_{i} \hat{p}_{i} + \sum_{j=1}^{n} \sum_{j=1}^{n} \hat{p}_{i} \hat{p}_{j} + \sum_{j=1}^{n} \sum_{j=1}^{n} \hat{p}_{i} \hat{p}_{j} \hat{p}_{j} \right]$ and the sequence of the stage of the error $\frac{1}{2}$ expecting to the error rates at a pre- $\delta_{\rm ph}$ specified level and the simple procedures which ignore spatial correlation and δ $\left[\begin{array}{ccc} \mathbf{1}_{t} & \mathbf{$ $T_{\rm eff}$ The operation of the methods are shown through a simulation study, indicates are study, indicates as in $\begin{bmatrix} \alpha_{\text{eff}} & \text{if} \ \$ method, but the accounting for correlation $\frac{1}{2}$ in the individual voxelwise thresholding methods. The methods are illustrated with a real bilateral finger tapping experiment. **Some Keywords:** Familywise Error rate; False Discovery Rate; Spatial Correlation; Per- $\mathbf{E}[\mathbf{x}_1, \mathbf{x}_2, \dots, \mathbf{x}_n]$

 $\mathbb{E}[\mathbf{A}, \mathbf{A}^T]$ experiments have a common objective of identifying and \mathbf{A}^T roine 1 , and 1 single substitute in single substantial subject experiments for example by performing p individual votel of the number of the number of the number of the observed time course is not significant time icantly reference in a signed reference function (Bandettini et al., 1993; Cox et al., 1993; Cox et al., 1995) $\mathcal{N}_\mathbf{q} = [1,2\pi]$ and $\mathbf{q} = \mathbf{q}$ then a thresholding rule to the resulting rule t_{\star} s $|z_{\star}z_{\star}\rangle$

This paper describes the formal matrix \mathbf{r}_i and \mathbf{r}_j rates \mathbf{r}_i and \mathbf{r}_j is formally set active to \mathbf{r}_i thresholds based on individual voxelwise test statistics, but not on cluster size. We review \mathbf{a} is defined at a pre-specified executive pre-specified level at a pre-specified level at a pre-specified level at a pre-specified level at a preinclude simple procedures procedures which ignore spatial correlation \mathbf{I}_r], as $[n]$ as $[n]$ as $[n]$ as $[n]$ as $[n]$ in the operation information. The operation information in $[n]$ action of the methods of the methods are shown through a simulation study. A real bilateral fingeral bilateral fingeral final tapping experiment is used to illustrate the methods and conclusions.

 $A = A e^{-\frac{1}{2} \pi}$ common significance of a statistical hypothesis test is to specify the specific specifies is to specify the specifies is to specify the specifies is to specify the specifies in the specifies is to specif $\mathbf{r}_i = \begin{bmatrix} \mathbf{r}_i & \mathbf{r}_$ determine a threshold. The type I error rate is the probability that is the probability that, if the voxel were truly the voxel were truly that if the voxel were truly that if the voxel were truly that if the voxel were t inactive, its test statistic would be the threshold and we would incorrectly and we would incorrectly conclude it is active. The this significance level determines the threshold, so that for example, a ψ $v_{A} = \frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{$ is a important problem in the consideration of the constant of \mathbf{I}_r in the constant \mathbf{I}_r volume in \mathbf{I}_r in the constant of \mathbf{I}_r in the constant of \mathbf{I}_r in the constant of \mathbf{I}_r in the constant $\mathbf{r} = [\begin{array}{ccc} \mathbf{r} & \math$ expect . $\sqrt{4} + 3$ vote $\sqrt{4} + 3$ vote $\sqrt{4} + 3$ we assume that is kind of the result is a large number of the result is a large number of $\frac{1}{2}$ declared active when they are the reason for the $\frac{1}{2}$ $\mathcal{P}_{\mathbf{e}}$ and $\mathcal{A} = \begin{bmatrix} \sqrt{a} & \sqrt{a^2 + 2} & \sqrt{a^2$ A_{α} , it is a result of this problem of excessive false positives, it is useful to consider \overline{A}

 σ ereror rates which account for the multiplicity problem. Some notation needs to be later to be later to be laid out of the multiplication of the multiplication needs to be later to be later to be later to be later to $\overline{56}$ see process in the $\overline{16}$, $\overline{1}$, relation at \overline{z} and \overline{z} if T_i z and \overline{z} and \overline{y} and \overline{y} and \overline{z} and \overline{z} if t_i p_i P $|T_i| > |t_i|$ is an ii p_i i p_i relation of \overline{G} \overline{V} \overline{f} i, and γ \overline{g} is an observed threshold set \overline{f} and \overline{g} and \overline{g} and \overline{g} is an observed threshold set \overline{f} $v_A = -1$ $\frac{1}{2}$ \frac active. We define Eⁱ : {|ti| > γ|µⁱ = 0} to be the event that the test statistic in voxel i e_{γ} **2** 2 e_{xt} x y when \overline{q} is the state in $i \neq 1$

 $\mathbf{R}_{\mathbf{q}}$ مِ إِنْ الْمِيمِهِ مِنْ الْمِيمِينَ بِينْ الْمِيمِينَ بِينْ تَجْرَى إِلَى يَعْمِينَ إِيمِينَ الْمِيمَا $\mathbf{v} = \mathbf{z}$ and $\mathbf{w} = \mathbf{z}$ and per comparison error rate. The perception error rate (or per voxel also call it the perception of \mathbf{v} er a referred and it refers to the probability of a fact $\frac{1}{2}$ finding $\frac{1}{2}$ and $\frac{1}{2}$ individual votel ind $U_{\mathcal{P}}$ using our notation, the performance of the performance \mathbf{F}_i is the event Einstein Einstein Einstein Einstein Einstellung Einstellung E_i

PCE $P E_i$.

The most common way in the statistical literature to account for multiplicity is to consider the consideration of α $\begin{bmatrix} 1 & 1 & 1 \end{bmatrix}$ in $\begin{bmatrix} 1 & 1 & 1 \end{bmatrix}$ in $\begin{bmatrix} 1 & 1 & 1 \end{bmatrix}$ is the family is the probability of $\frac{1}{2}$ in the image one false positive on any vote $\frac{1}{2}$ in the image, $\frac{1}{2}$ in the image, $\frac{1}{2}$

FWE $P_{i}E_{i}$.

 \mathbf{A} is \mathbf{FWE} PCE_{γ} and \mathbf{A} is the FWE at level and \mathbf{FWE} at level at level at level and \mathbf{FWE} \mathbf{A} then one which controls the PCE at level at level at level at level \mathbf{A} made between methods which only control the second versall number of \lfloor $\overline{v}_{\overline{q}} = \sqrt{\overline{v}_{\overline{q}} + \overline{v}_{\overline{q}} + \overline{v}_{\overline{$ control the FWE under any number of votels have numbered and treatment-relationships \mathbf{r} $\frac{1}{2}$ and $\frac{1}{2}$ and $\frac{1}{2}$ of the Fundred strong control of

 R ecently there has been much interest in a third corresponding containing \mathbf{R} (FDR). The expected proportion of $\sqrt{|\mathcal{F}|^2}$ is the total positives to the total positives to the the the theorem is the total positives to the the the theorem is the total positives of the theorem is the theorem in t expected proportion of the truly indicative vocal of the total number of tota of votels declared active. This is in the letters in the letters in the letters in the letters in each cell refer to the counts of the number of individual hypotheses falling in the corresponding in the corresponding category. For V is the number of \overline{v} is the number of individual and \overline{v}

 \mathbf{A} \mathbf{B} \mathbf{C} and \mathbf{C} and \mathbf{F} is a false is

 FDR E V/R ,

where the ratio V/R is defined to be R is the ratio of R is notation, and using the V/R is not at using the R FWE $PV >$.

In the case where all null hypotheses are true (called the global null hypothesis), then the number of false positives V is equal to R, so that V/R = 1 if R > 0 and 0 otherwise. The FDR under this scenario simplifies to

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FDR \quad P \quad R > \qquad FWE.
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3. Methods for Controlling the FWE

The simplest way to control the FWE is the F is the Bonferrence method. The Bonferrence method. This is the Bonferrence met s_{max} simply divide the individual threshold significance level \mathbf{r}_i m 2.4 **head** 3 a ali γ 3 and γ a γ for a ali test. The α' and $m \in \mathcal{A}$ is γ ali test. This is a significance vocal test. This is a significance vocal test. This is a significance vocal test. This is a g_{α} je jarantees that the FWE is no larger than an intervals of α , since α

 FWE $P_i E_i$ $P_i E$ \cdots $P_i E_m$ $m\alpha'$ α .

 $\sum_{i=1}^n \frac{1}{\sqrt{2\pi}}\exp\left(-\frac{1}{2\sqrt{2\pi}}\int_0^1 \frac{1}{\sqrt{2\pi}}\exp\left(-\frac{1}{2\sqrt{2\pi}}\int_0^1 \frac{1}{\sqrt{2\pi}}\right) e^{-\frac{1}{2\sqrt{2\pi}}}\right)$ the FWE (i.e. fewer voxels declared active) in many situations because the approximation

ignores intersections of the executions of events events in the test security of the test severe when the test of th s_{μ} statistics are moderated. Functional moderated is exhibited. Functional moderated is μ $\frac{1}{3}$ spatial autocorrelation, where $\frac{1}{3}$ are more strongly correlated with one strongly correlat and a result of the result of the conservative behavior of the conservative of the Bonferries of the second is $\frac{1}{2}$ power to detect the vocal to detect the vocal set of \overline{v}

 T sharpen the Bonferronian procedure and obtain less conservative conservative conservative conservative control of the FWEE $\begin{bmatrix} a & b & d & e \end{bmatrix}$ on the distribution active active must set the distribution of the distribution maximum |T| statistic. This is because the FWE for threshold γ can be written as

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FWE \t - P \t |T \t | \t \gamma, \ldots, |T_m| \t \gamma \t - P \t | \t |T_i| \t \gamma,
$$

 $s_{\mu\nu}$ s the exact threshold a f α _is $-\alpha$ is the maximum of the maximum α $|T|$ and can consider the consider thresholds based on the minimum vocal constant \mathbf{v} p-value. This distribution is dependent on the correlation structure of the t statistics, and $\left[., \rightarrow a \right]$ in any $\mathcal{V} \left[. \right]$

 $R_{\rm B}$ random field methods were first applied to functional neuroimaging data to approximate to app this max $T/[T]$ distribution by Friston et al. (1991) and $\frac{1}{2}$ and $\frac{1}{2}$ the m t_{+} statistics can be viewed as a lattice representation of a lattice representation of a continuous Gaussian of t_{+} related for \overline{u} \overline{v} \overline{v} \overline{v} \overline{v} and smoothness parameter \overline{v} is the non-then is then is then \overline{v} is the non-then is then is then is then is then is then is then is the non-then is then i used to estimate the exact γ threshold value corresponding to FWE α, i.e. the (1 − α percentile of the max percentile of T distribution. Equivalently in a $p\psi$ of T $f(\bm{x})$ pi, and \bm{y} is the probability the maximum $|T|$ statistic exception \bm{y} (bing \bm{y} at \bm{y}) the probability that the minimum probability than probability than pinimum probability of $p\psi$, $\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ and $p\psi$, $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ compared directly to a to determine if $\left[\begin{array}{ccc} 0 & \frac{1}{2} & \$ theory, Friston et al. (1991) and $\int_{\mathbb{R}^d}$ pi by a pi by a given pi by a pi by $\int_{\mathbb{R}^d}$ pi by and pixel pix

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E\ d\qquad S\ \ \pi^{-(m+1)}/\ W^{-m}p_i^{-m}\quad\bullet\quad -p_i/\quad.
$$

 \mathbb{R}_{γ} et al. (1992) et al. (1992) elaborate on this approximation by using the expected Euler charaction in place of E d). Alternatively, the simulated may be simulated.

 $F(x, t) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ on $F(x, t) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ H_{α} , α) and α (ii) and alternative way of the maximum of th $\int T/_\gamma$ single. The propose to simulate to simulate the exact Γ values γ values γ is exact permutation respectively. $\sum_{i=1}^{n}$ the multiple scans over the number of the data from th exchangeable (have the same distribution), we can generate the exact empirical distribution of the max |T| statistic by enumerating each permutation, recomputing each voxel t statis- $\begin{bmatrix} \mathbf{a} & \mathbf{b} & \mathbf{c} & \mathbf{$ predice, one takes a random sample of possible permutations rations rations rather than $\lfloor \frac{1}{\pi} \rfloor$ one, because the number of permutations becomes problems problems problems problems problems \mathbf{r} \mathbf{a} beample, with n \mathbf{a} time points, there we have \mathbf{a} possible permutations. A random sample of the sample of the sample of the max $\frac{1}{T}$ distributions T and $\frac{1}{T}$ which converges to the true distribution with increasing \mathbf{y}_t يد [د] ديد [بعد بع—، السيمبيد[أكبيات بعد دخصين [بها $\mathbf{r}_\text{eff}=[\mathbf{r}_\text{eff}^T,\mathbf{r}_\text{eff}^T]$ instead would permute that one instead would permute the residuals after \mathbf{r}_eff fitsing a model in time time time trend. Also, the time course \mathbf{r}_i is the time course may exhibit temporal autocorrect may be autocorrect m relation. Locascio et al. (1997) estimated the temporal autocorrelation using a parametric model, which data based on this estimate, and $\frac{1}{2}$ is equally permutation processed the permutation proces dure to the white in order to the maximum in order to estimate the maximum of the maximum of the maximum $|T|$ statistic. $\lceil \log n \rceil$ itting and whitening the data make the residuals approximately exchange $\lceil \log n \rceil$ $\begin{bmatrix} 1 & 3 & 3 & 3 & 3 & 4 & 4 & 3 \end{bmatrix}$ are only estimated from the true values. In the true values of the true values. In the true values of the true values of the true values. In the true values of the true values of the practice, the procedure works well assumed to the model is corrected in the model is correct. The model is corrected in the model is corrected in the model in the model is corrected in the model in the model in the model In conclusion, methods for controlling the FWE require a threshold to be set based on the FWE require and the set based on the FWE require and the set based on the FWE require and the set based on the set based on the set adistribution of the maximum $|T|_{\phi}$ statistic. Many possibilities for estimating the many possibilities for $\frac{1}{2}$ existing permutation respective method is especially at the permutation of \mathbf{c} is equivalent permutation of \mathbf{c} applied to many situations, provided one can find $\frac{1}{2}$ and \frac $\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$ $\mathbf{M} = \begin{bmatrix} \mathbf{M} & \mathbf{$ consider when $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ a relevant constant to for $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ and $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

the probability of getting or more factor of f and f and f and f and f f f f f f The consequence of controller the FWE at a set of α means that we will have relatively a mean \mathbb{R}^n .

 $\begin{bmatrix} a & a & b & c & a & a \end{bmatrix}$ and $\begin{bmatrix} a & b & c & d \end{bmatrix}$ in the Bonferry procedure, we are adjusting procedure, we are adjusting to $\begin{bmatrix} a & b & d \end{bmatrix}$ the threshold for such a large number of $\mathbf{v} = \mathbf{x} \cdot \mathbf{y}$ and the signal or activity level will have the signal or activity level with $\mathbf{v} = \mathbf{x} \cdot \mathbf{y}$ \overline{t} be very strong to be above the above the above threshold.

 $\alpha = 1.76$ σ α β and α is to consider a problem is to consider a priori defined regions of interests of interests of interests of interests of interests of α $(\mathbf{R}^{\text{max}})$, one can control the interest, using interest $B_{\text{max}} = \left\{ \begin{array}{ccc} \mathbf{0} & \mathbf{0$ is less multiplicity adjustment because of reduced family size \mathbb{R}^n of vocals \mathbb{R}^n Therefore, this method will have to detect active voxels in that $\frac{1}{2}$ \mathbf{q} مصادر المعلمية والمجمعة والتقيم مدين سنهد المحامر المعامل المعلمين بالمعلمين المعلمين بعيد يعتبر يعجل جاه الأساحي بها جاهر الإسرائيل الجلال بما يعام المحجم بريعية و cantrolled be controlled. One example of an antiimage, so that only voxels inside the brain are considered in the multiplicity adjustment. This $\mathbf{r} = \begin{bmatrix} r & r & r \end{bmatrix}$ reduces the total number of vocal detect and improves the power to detect active ac $v \overline{A}$ in the brain and uncovered by the mask and v is not difficult to specify a mask a m prioring is a straightforward way to reduce the multiplicity and multiplicity and multiplicity and multiplicity, $\mathbf{F} = \mathbf{F} \mathbf{$ however, we do not consider the remainder in the remainder in the remainder in the remainder in the remainder

The FWE can be FWE considered to it unacceptable to the false positive occurring and \mathbb{F}_q positive occurring and \mathbb{F}_q in the thresholdes in the thresholdes in the some false is the some false positive in the some \overline{f} the number of $\frac{1}{2}$ thresholdes in the number of σ total positive findings. The basic strategy of controlling the basic strategy of controlling the FDR, and will be σ discussed next. 1

4. Methods for Controlling the FDR

 $B = \{A, B\}$ and $B = \{A, B\}$ and $B = \{A, B\}$ proposedure for controlling proposedure for controlling proposedure for controlling $B = \{A, B\}$ the FDR at F at \mathbb{F}_{p} , which was applied to neuroimaging data by Genovese et al. (2002). F_{ψ} **3 e 2 v**_{**4**} **pv**] ψ _{**_j** ψ **43 j p**₍₁₎ p₍₁₎ ... $p_{(m)}$ **3** (i) **443 3 v**₄} corresponding to p-value p(i). Then $p(i)$. Then $r \rightarrow p$ is $i \in \mathbb{R}$ in the largest intervalue in the largest intervalue of $p(i)$ $p_{(i)}$ i m \overline{a} . $\mathbf{R} = \begin{bmatrix} \mathbf{R} & \mathbf{A} & \mathbf{A} & \mathbf{B} & \mathbf{C} & \mathbf{A} & \mathbf{$ $\frac{1}{2}$ $\frac{1}{2}$

This procedure controls the FDR at level $q \leq \frac{1}{2}$ of $q \leq \frac{1}{2}$ and positively dependent and positive dependent a $\psi_{\mathbf{A}}$ and Yekuties (Benjamini and Yekuties and Yekuties and Yekuties and General correlation structure structure and $\psi_{\mathbf{A}}$ ساد د[د میر دیم محامله میرسد] می اسد] می آمدم دم دست \mathcal{L} above \mathcal{L} if \mathcal{L} if \mathcal{L} is above to be the largest integration of \mathcal{L} $p(i)$ i $\frac{1}{m}$ \overline{a} $\frac{q}{\sum_i /i}.$ A \overline{V} and A and A and A is preference active. So it is preference active. So it is preference to it is preference active. So it is preference to it is preference to it is preference to it is preferable to it u_{γ} s the first procedure united the first negative correlations are likely. In a correlations are likely. $\mathbf{S}_{\mathbf{R}}$, $\mathbf{\tau} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$ which $\mathbf{R}_{\mathbf{R}}$ is a call \math (b) \mathbf{b} : $pFDR$ E $V/R/R$ > \ldots $\mathbf{F} = \begin{bmatrix} \mathbf{F}^T & \mathbf{F}^T &$ interpretation (Storey 2001b) as τ as $\frac{1}{2}$ $pFDR$ p P H_i , \bullet $||T_i| > \gamma$, $\sigma_{\rm e}$ the posterior probability that the voxel is in that its test statistic is that its test statistic is the interest statistic is the interest statistic is above that its test statistic is above that its test stati the see there is see that conditional on V S R, then V s and V is a number of \sqrt{t} which are falsely declared and V is B p) where p is B inomial is H_i is the probability that W is B is that H_i is that W is D is that H_i is that W is D is that W is D is that W is D is H_i \overline{t} $\overline{$ $pFDR$ E $V/R/R >$ $E_{R>_{\searrow}} E \; V/R/R$ $E_{R>}$, p V S / V S p . $\mathbf{S}_{\mathcal{B}}$, ∇ interpretation as $\left[\begin{array}{ccc} 1_y & 0 \\ 0 & 0 \end{array}\right]$ interpretation interpretation interpretation interpretation in terms interpretation in terms in $\mathbf{a}_t = \mathbf{b}_t + \mathbf{b}_t = \mathbf{b}_t$ in the following way: $pFDR$ $\frac{P}{|T_i|} \frac{\gamma |\mu_i|}{\gamma |\mu_i|} P_{\mu_i}$

 \overline{P} |T_i| γ $F \gamma \pi$ $\frac{\gamma}{F} \frac{\pi}{\gamma}$, where F is the complete integration of $|T_i|$ is in the complete integration vote in the complex integration of $|T_i|$ of the marginal CDF of |Ti| regardless of activity (a mixture distribution of F and an unknown alternative distribution F), π and $/m$ is the proportion of $\frac{1}{n}$ is the proportion of F (a, a) is \overrightarrow{v} .

 T , τ , θ and θ and θ and θ and θ and θ these θ and θ of these θ these θ and θ and tities. Parametric models assumed that is not assumed that proved in the computer of $p \in \mathbb{R}$ is a subserved from the observed f $v\overline{A}$ is the statistic method of the nonparametric \overline{a} is the distribution of the distribution of \overline{a} τ tion of the voxel test statistics. Parametric test to the top identical to the BH τ 3 a correspondent that the p-value point the p-value p(i) correspondent to the threshold $P(i)$. We can estimate F γ(i)) by the proportion of rejected hypotheses, so that F γ(i)) = i/m A_{ψ} and conservative extra conservative estimate of parameters of \mathcal{A} $pFDR$ $mp_{(i)}/i$, \rightarrow \rightarrow

$$
pFDR \qquad q \qquad \qquad p_{(i)} \qquad \frac{i}{m}q.
$$

 \mathbf{r} (Therefore the p-values \mathbf{r} and \mathbf{r} \mathbf{r} and \mathbf{r} t_{+} statistics turns out to the equivalent to the BH method.

 $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$, which could be obtained using $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ pling or Gaussian random field methods above, could method above, could also be into the into t pFDR estimate. However, as the mean of the marginal number of $\mathbf{F}_{\mathbf{y}}$ and $\mathbf{F}_{\mathbf{y}}$ is simulated the matrix of $\mathbf{F}_{\mathbf{y}}$ and not to incorporate the correlation into the correlation into the FDR estimate into the FDR estimate into t $\overline{}$

 \vec{v} eral authors (Storey, 2001a, 2011a, 2001a, 2001a, 2000) have considered adapted and Hochberg, 2000 \mathbf{r}_k to further refine the FDR-controlling procedure. However, in the FDR-controlling procedure. However, in most controller procedure. However, in most controller procedure. However, in most controller processes in fMRI datasets, we expect that a relatively small proportion of the voxels in an image would $[a,b]$ and considered as $[a,b]$ in this setting, there are may be limited may be limited with \mathbf{a} utility in estimating π because the estimating typically be very close to one. The very close to one. The o

 $\mathcal{F}[\mathbf{a}, \mathbf{b}]$ powerful procedure, powerful procedure, and it has two main limitations. It is not only it it is defined as two main limitations. It is not only it is not only if \mathbf{b} $\frac{1}{2}$ for a formulate to control to contr and if the statistics are positively correlated, it may not be as powerful as powerful as p as p which does incorporate correlation in the intervention in the correlation of the correlation in the correlation in the correlation in the correla exhibit some spatial correlation. The spatial correlation of the constant methods for consider m the FDR when the FDR when the FDR when the seated present. Year of the Benjamini (YB, 1999) propose a seated p **p** $\begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ to be the random variable random variable variable

$$
1.01 + 43.44y - 3
$$
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$$
2.4 \times 10^{2} \text{ N} \cdot \text{m} \cdot \text
$$

$$
E\left[\frac{R \ \gamma}{R \ \gamma \quad S \ \gamma}\right] \ \mathbf{M}_{\gamma} \ \mathbf{S} \ \mathbf{I} \quad \mathbf{S} \quad \mathbf{E} \left[\frac{V \ \gamma}{V \ \gamma \quad S \ \gamma}\right].
$$

In this expression, we can estimate S $\gamma \rightarrow \tau$

$$
S \gamma \qquad R \gamma \quad -m p_{\gamma},
$$

where $R \gamma$ is a continuous mumber of the number of the observed in the p_γ is $p\psi$ ⁻ de to the threshold to the threshold γ threshold $\tilde{\textbf{f}}$ then the final estimator is the final esti $\begin{bmatrix} R & \gamma & 1 \end{bmatrix}$

$$
\widehat{FDR}_{YB} \gamma \qquad E\left[\frac{R \quad \gamma}{R \quad \gamma \qquad S \quad \gamma}\right].
$$

$$
4 \t\t e \t3] \t3a_4 + t \t{1} \t3 \t7a_4 + 3 \t5a_4 + 4t \t7 a_3 + 6
$$

\n
$$
a \t1_{f} t \t1_{f} 3 \t1_{f} 4 \t7_{f} 5 \t7_{f} 4 \t7_{f} 6 \t7_{f} 7 \t7_{f}
$$

 γ

$$
\mathbf{v} \quad \begin{bmatrix} \mathbf{v} & \mathbf{
$$

These FDR estimates can be used in a step-up procedure and a step-up procedure analogous to the BH pr $\begin{bmatrix} 1 & \sqrt[4]{3} & \sqrt[$

denote the voxel corresponding to p-value p(i). Compute the corresponding \mathbf{P} $f(\bullet)$ and denote the position of provalent for p(i) as $f(\bullet)$ and $f(\bullet)$. \ln_{f} $\lim_{r \to 0} i \leq \frac{1}{2}$ a. FDR $\lim_{Y \to 0} p(i)$ a. Conclude that the voxels $\ln_{f} p(i)$ are active, and are active, and and are active, and and are active, and are active, and are active, and are active, and are activ $\overline{}$. I as an are in a remaining ones are in an area in an The YB method can be used to control the FDR when the FDR when the FDR when the p relations, and it may be more powerful than the BH method because it explicitly incorporates it explicitly incorporates in \mathcal{F} $\begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ subset of $\begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$

 \mathbf{F}

 $\lfloor n \rfloor$ is generated to simulate a bilateral finger tapping for $\frac{1}{n}$ bereated design experiment of $\frac{1}{n}$ where $\frac{1}{2}$ and the true motor activation structure is the thresholding methods of the thresholding methods methods is $\frac{1}{2}$ $\begin{bmatrix} 1 & \mathbf{v} \end{bmatrix}$ $\begin{bmatrix} \mathcal{S} & \mathcal{$ \mathbf{z} , \mathbf{x} . Let \mathbf{z} be a given in Figure 1 are designated in Figure 1 are designated in Figure 1 and \mathbf{z} $\mathbf{t} = \begin{bmatrix} \mathbf{t}^T & \mathbf{t}^T & \mathbf{t} &$ $\lceil \frac{1}{2} \rceil$ is constructed according to a region model of $\lceil \frac{1}{2} \rceil$ and $\lceil \frac{1}{2} \rceil$ and $\lceil \frac{1}{2} \rceil$ which consists of an intervention of an intervention of a time transition of a time $\frac{1}{2}$ \vec{v}_q , \vec{v}_q also a reference function for \vec{v}_q $R = \{x_i, x_j\}$ is related to a block experimental design. 8 16 24 32 40 48 56 64 8 16 24 32 40 48 56 64 50 100 150 200 250 $T^{\{r\}}$ $v \overline{A}$ y $a \overline{B}$ and $b \overline{A}$ the $b \overline{A}$ time points, is represented in the matrices as $v \overline{B}$ in the matrices as $v \overline{B}$ Y X B E $n \times p$ $n \times q$ $q \times p$ $n \times p$ where q is the number of independent variables. $V_A - \mu$ in each $V_A - \mu$ are numbered sequentially from top left to both right. The sequential to both right σ $s_{\varphi,\varphi}$ is generated as is generated and φ is an φ is an isomorphic the design matrix φ is an isomorphic to K is an isomorphic to K . In an interventional vector of n and α ones, the second column is at an n n

dimensional v \overline{a} the first conting numbers, and the third column is and the third column is an \overline{a} v^2 consisting of eight replies of eight replications of eight ones. The true regression of \mathbf{r} coefficient matrix B of \mathfrak{p}_A of C outside \mathfrak{p}_A are \mathfrak{p}_B are \mathfr random independent noise for the nonzero elements with zero mean and standard deviation α . 25. Institute each Roise each Roise coefficients associated with the reference function are \mathbb{R}^n $g \notin \overline{A}$ in \overline{B} of \overline{C} i, j condinates by \overline{C}

$B \, i,j\,e^{-\frac{(i-i')^2+(j-j')^2}{2(2)}}$.

 ψ is the vocal number in the center of the coefficients were chosen to the coefficients were chosen to the chosen to the coefficients were chosen to the coefficients were chosen to the coefficients were chosen to the c $\| \psi^{-1} \|_{\mathcal{A}}$ and \sqrt{s} and \sqrt{s} and smaller ϕ in the center and smaller effects the ce ϵ but with reasonable power after multiplicity and ϵ the activations. $\begin{array}{ccccc} \vec{v} & \vec$ R and all $\sqrt[n]{a}$ in the second vocal is correlated with a second vocal of p where p Euclidean distance between the voxels. The observation errors is the observation errors in $V_{\rm eff}$ independently form a multiply from a multiply p distribution p distribution p and p and p and $p \times p_0$ positive fractional matrix $p \times p_0$ and $p \times p_0$ are p_0 in the variance and correlation $\sum_{i=1}^n \sigma_i R_i$ in the variance p were selected to be σ = 64 and ρ = 0.0, 0.7, or 0.95.

 $\mathbb{F}_{p^{2k+1}}$ the thresholding methods were considered: Unadjusted method with type I error of $\mathbb{F}_{p^{2k+1}}$ \int antichadore with $\mathcal{A}^{\mathcal{C}}$ of $\mathcal{A}^{\mathcal{C}}$ and $\mathcal{A}^{\mathcal{C}}$ and the FWE at $\mathbf{r} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 &$ procedure with a FDR of $\left[\begin{array}{ccc} \overline{a} & \overline{b} & \overline{c} & \overline{d} \\ \overline{c} & \overline{d} & \overline{d} & \overline{d} & \overline{d} \\ \overline{d} & \overline{d} & \overline{d} & \overline{d} & \overline{d} \end{array}\right]$ permutations. Because of the computations of the computational burden, see the created images were computations which each of the set of these methods was applied. For each procedure, a power in \mathbb{R}^n which summarized the frequency over the $\frac{1}{2}$ in $\mathbf{a} = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}$ as active the respective threshold). For clarity, all voxels which are never وصيار في المسلم من ا
مسلم من المسلم من ا expression the power or frequency with which they are declared active. They are declared active. The set in a theorem is \mathbf{r}_i $g_{\mathcal{A}}$ in $g_{\mathcal{A}}(x, y) = \frac{1}{2} \int_{\mathcal{A}} \nabla \cdot \vec{p} \cdot \vec{p}$. Also included in $\rho = \frac{1}{2} \int_{\mathcal{A}} \rho \cdot \vec{p} \cdot \vec{p}$

(e) FDR BH method

(f) FDR YB method

(b) Unadjusted threshold

(a) Sample t-statistic image

(c) FWE Bonferroni method

(d) FWE Permutation method

(e) FDR BH method

(a) Sample t-statistic image

(b) Unadjusted threshold

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(d) FWE Permutation method

(e) FDR BH method

the figure of $\lim_{n \to \infty} \int_{0}^{1} f(x) dx$ figure is a single set of $\lim_{n \to \infty} f(x)$ or $\lim_{n \to \infty} f(x)$ is given the statistical from $f(x)$ the corresponding model and controlled and covariance matrix. The second covariance of the effect of the effec $\textbf{t}_i = \begin{bmatrix} \textbf{s}_i & \textbf{t}_i & \textbf{t}_i \\ \textbf{t}_i & \textbf{t}_i & \textbf{t}_i \end{bmatrix}$ image $\begin{bmatrix} \textbf{s}_i & \textbf{s}_i & \textbf{t}_i \\ \textbf{s}_i & \textbf{s}_i & \textbf{t}_i \end{bmatrix}$ $\left[\frac{1}{2}$ and constant to notice to notice in a $\frac{1}{2}$ degree of the image of the ima $[t_{+}$ statistic values, while the image with $[t_{+}$ and $[t_{+}$ in $[t_{+}]$ are are areas of clustering. The spatial independent of clustering. The spatial independent of clustering. The spatial independent of clustering ρ correlation structure of \mathbb{R}^2 and \mathbb{R}^2 is expected to respect to respect to ρ . $s_{\rm F}$ scenarios, and is not likely to be as strong as the position of $\frac{1}{2}$ In all the unadjusted method of unadjusted method of the second method of the \mathbf{f} power, but a substantial number of \sqrt{p} substantial number of \sqrt{p} in the fact positive positive p in the fact po entire 64 in the 64 institute active active at least one in the 500 simulated images. In the 50 For the zero correlation scenario, there appears to be no benefit to using a permutation $s_{\rm eff}$ s account for account for correlation. The FWE Bonferrence method and the FWE Bonferrence permutation method is virtually in the following power in the FDR BH method and \mathbf{F} the FDR yet is a substantial method. However, there is a substantial difference between a $\mathbb{F}_{p}[\mathbf{y} \mid \mathbf{y}]$ procedure and a FDR-controlling procedure. The FDR-controlling procedure. The FDR-controlling procedures maintains \mathbf{r}_i higher power in the ROI than the ROI than the ROI than the FWE-controlling process of more cost of more cost o f_{γ}^{α} detected voxels. However, the proportion of f_{γ} detection of f_{γ} and v_{γ} is still maintained vocals in still matrix. $[a]$ a $[\mathbf{a}^{\mathbf{b}}]$ a $[\mathbf{a}^{\mathbf{b}}]$ or $[\mathbf{a}^{\mathbf{b}}]$ $[\mathbf{a}^{\mathbf{b}}]$ and $[\mathbf{a}^{\mathbf{b$ \mathbf{A} results can be seen for the model model of ρ = 0.7. The model of ρ = 0.7. Even for ρ $\tau_{\rm eff}$ the spatial correlation is stronger, there is still like is still like incorporation in $\tau_{\rm eff}$ the correlation information in the correlation of the FWE or FUE or FUE or FUE or $\frac{1}{2}$ controlling procedures. The is probably because that is probably probably probably process are described. between any votal and any votal and any votal is very low. Therefore, a new low. Therefore, \overline{a} and $x = t$ of a 1 ₄ \rightarrow 4 a very 1 t or \rightarrow $\frac{1}{2}$ or \rightarrow $\frac{1}{2}$ and \rightarrow $\frac{1}{2}$ and \rightarrow $\frac{1}{2}$ and \rightarrow $\frac{1}{2}$ most of the values will be considered to $\frac{1}{2}$ in $\frac{1}{2}$ in the space $\frac{1}{2}$ correlation $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ order values of $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ order $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ to both to both computing the computing the correlation between each pair of voxels, and \mathbf{r} correlations to a correlation in the correlation i $\lfloor \frac{1}{\sqrt{2}} \rfloor$ above 1. Since the correlation matrix is space in the incorporation matrix is little advantage. In the incorporation matrix is little advantage to incorporation matrix is little advantage. In the second s_{ϕ} are long and information in the multiplicity adjustment. However, the multiplicity and is still and interesting and s_{ϕ}

in the portal anti-portal controlling power to use a F power to use F Finally procedure, similar to when the correlation \mathbb{F}_p

 \mathbf{A} is very spatial correlation is very strong in the case of \mathbf{A} is very set of \mathbf{A} respective to the power to detect vocal activations. The power to detect vocal activations. The FWE permutation sampling procedure detects a larger portion of the activation region with higher power than the FWE Bonderroom than the FME FOR YB results in the FDR YB results of \mathbb{F}_p respectively. المالية المجامعين.
يجاد المحامين جميعية المجامعية بعد بمحامية معام المحامين بما يجامع المجامعين. relation of 0.95, the correlation between and a neighbor \mathbf{r}_i and \mathbf{r}_i votels are \mathbf{r}_i votels and \mathbf{r}_i votels are \mathbf{r}_i votels and \mathbf{r}_i votels are \mathbf{r}_i votels and \mathbf{r}_i votels are \math 0.7 and 0.54 respectively, and the initial map with in Figure 5 by a correlation map with a correlatio $\left[\begin{matrix} k_{\text{f}} & k_{\text$ autocorrelation is utilized by the response of \mathbb{R}^n the results methods to the power relative to the powe noneres are sampling counterparts. As a controlling method methods are more powerful methods are more powerful than the FWE-controlling methods. However, as indicated by the sample t-statistic image, \mathbf{t}_r s_{p} spatial autocorrelation of this extent is unlikely to be encountered in fMRI data.

 $f \in U$ or Population in a set of \mathbb{R} in a set of \mathbb{R}

(a) $\rho = .00$ (b) $\rho = .70$ (c) $\rho = .95$

 T below provides a below provides and magnitude on the magnitude of the magnitude of the power differences of the power between the various methods, as well as the error rates of \mathbb{R}^n The FDR-controlling procedures appear to improve the average to improve the active r $b \rightarrow b$ approximately 14%. The respective to incorporate correlation in the correlation in prove the correlation in prove the correlation in the correlation in prove the correlation in the correlation in the correlation in $p \mapsto \overline{p}$ about \overline{p} about p . $\begin{bmatrix} \cos\varphi & \sin\varphi & \sin\varphi & \sin\varphi & \sin\varphi & \cos\varphi & \cos\var$

correlated regions of the brain all others, since the correlation of the correlation of the correlation of the correlation matrix \mathbf{r}_i and \mathbf{r}_j is the correlation-based multiplicity and \mathbf{r}_i the power to detect active vote \overline{u} is detected active over \overline{u}

To illustrate the thresholding methods described in this paper, a bilateral finger tapping experiment was performed with the same design as the same design as the parties p $g_{\alpha\beta}$ generate tapping tapping tapping tapping was performed in a block of p e_{ij} being e_{ij} on and e_{ij} on and f_{ij} and f_{ij} bruker Biospec in \mathbb{R} by \mathbb{R} by which is a size of size \mathbb{R}^d and \mathbb{R}^d were accurred. The component in matrix in model of \mathbb{R}^d 125 X . $X = \mathbb{R}$ \mathbb{R} , \mathbb{R} , \mathbb{R} is the \mathbb{R} so that \mathbb{R} is the \mathbb{R} so that \mathbb{R} is the \mathbb{R} is that \mathbb{R} is the \mathbb{R} is that \mathbb{R} is the \mathbb{R} is that \mathbb{R} is t there are 128 in each voxel of the motor cortex was selected. Deputy the motor cortex was selected was s $f(\vec{r})$ and $f(\vec{r})$ and $f(\vec{r})$ multiple region model was fit to the data with an intervention \vec{r} and a reference function of reference in the replication of the replication of the replication of the state of the $\frac{1}{2}$ negative ones, which minicipal minics the experimental design in the simulation study. After fitsting the regression model is correlated the correlation model in the residence of $\frac{1}{2}$ $\left[\begin{array}{ccc} 0 & 0 & 0 \end{array}\right]$ and a correlation image was correlated. The same correlation is sample to the correlation in a correlation in a correlation in a correlation in a construction in a correlation in a correlation i and $\sqrt{2}$ in the magnitude and spatial correlation and spatial correlation among votal correlation among votal correlation and $\sqrt{2}$ l_f is sample distinction in figure sample sample correlation in the sample l_f is l_f and l_f is l_f and l_f is l_f and l_f

 $[t_{\gamma}, \mathbf{s}]$ satistic maps generated from the spatial autoregressive models with t_{γ} and ρ . \ldots , and \mathbf{s}_{γ} as described in the simulation study.

 $A_{\mathcal{A}}$ and $\begin{bmatrix} \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \end{bmatrix}$ are the same that A $\mathbf{s}_\mathbf{p}$ spatial correlation structure as the generated images, it appears that the magnitude and magnitude and $\mathbf{p}_\mathbf{p}$ s_{ρ} sparsity of the situation of this real dataset is similar to the situation where ρ = 0.7, and s_{ρ} and s_{ρ} \mathbf{I}_γ as ρ = 0.95. Therefore, we we would be to be little between using the little between using \mathbf{I}_γ a thresholding method which does not account for spatial correlation and one which does not account for α account for spatial correlation. The real data t-statistic image is given in Figure 7, and t_{ϕ} is given in Figure 7 with the sequence in the methods of the methods discussed with a $\frac{1}{2}$ error rate. In the methods of the methods

(a) Sample t-statistic image

(b) Unadjusted threshold

(c) FWE Bonferroni method

(d) FWE Permutation method

(e) FDR BH method

(e) FDR BH method

(f) FDR YB method

(e) FDR BH method

(f) FDR YB method

(a) Sample t-statistic image

(b) Unadjusted threshold

(c) FWE Bonferroni method

(d) FWE Permutation method

(e) FDR BH method

 A_{γ} expected, there are little to no differences between the permutation of γ responding the $\begin{bmatrix} \mathbf{r} & \mathbf$ expected, there are more votation the threshold using the FDR adjustment to the FDR adjustment to \mathbf{F} $\mathbb{F}_{\mathbb{F}}[\mathbb{F}_{\mathbb{F}}^{*}] = \mathbb{F}_{\mathbb{F}}[\mathbb{F}_{\mathbb{F}}^{*}] = \mathbb{F}_{\mathbb{F}}[\mathbb{F}_{\mathbb{F}}^{*}] = \mathbb{F}_{\mathbb{F}}[\mathbb{F}_{\mathbb{F}}^{*}] = \mathbb{F}_{\mathbb{F}}[\mathbb{F}_{\mathbb{F}}^{*}] = \mathbb{F}_{\mathbb{F}}[\mathbb{F}_{\mathbb{F}}^{*}] = \mathbb{F}_{\mathbb{F}}[\mathbb{F}_{\mathbb{F}}^{*}] = \mathbb{F}_{\mathbb{F}}[\mathbb{F}_{\mathbb{F}}$ $\mathbf{a} \cdot \mathbf{b}$ and $\mathbf{c} \cdot \mathbf{c}$. $\mathbf{b} \cdot \mathbf{c}$ and $\mathbf{c} \cdot \mathbf{c}$ in Figures 8, 9, and 10. The 10 $s_{\phi,\phi}$ similated the real and simulations in results indicates thresholded results indicates that the simulations indicates the simulations in ϕ $g:[e_1]$ and $g:[e_2]$ are a realized data.

 $\mathbf{F}_\mathbf{p} = \begin{bmatrix} \mathbf{F}_\mathbf{p} & \mathbf{F}_$ by other authors, the FDR-controlling methods generally $\mathbf{F}[\mathbf{v}]=\mathbf{F}[\mathbf{v}]=\mathbf{F}[\mathbf{v}]=\mathbf{F}[\mathbf{v}]$ controlling methods to detect and the $\mathbf{v}_i = [t \, \mathbf{e}_i]$ of the average magnitude of this power improvement. \mathbb{R}^n in the simulations \mathbb{R}^n in the simulations considered, but this is likely to be sensitive sensitive sensitive \mathbb{R}^n to the unity of the unity parameters in the size of the size of the size of the image considered. However, the image considered and the image considered. However, the image considered and the image considered. However, th procedures are controlling to different error rates, so this text controllers at this higher power comes at the cost of the c σ σ $\left[\rho$ a greater rate of $\frac{1}{\sqrt{2}}$ is equivalently applications, because of the large number of the large nu of \overline{v} votels controlled, controlling the FWE is less appealing to \overline{v} and controlling the FDR at at any controller than controller than controller than controller than controller than controller than \overline{v} fiels α d is and a set allowed vote is the number of allowing set and active is the isotherapy of active is then α linked to the total number of voxels declared active.

 $S_{\mathcal{A},\mathcal{A}} = \begin{bmatrix} S_{\mathcal{A},\mathcal{A}} & S_{\math$ $\mathbf{1}_{\mathbf{C}}$ thresholding methods which use $\mathbf{I}_{\mathbf{C}}$ and $\mathbf{I}_{\mathbf{C}}$ account $\mathbf{I}_{\mathbf{C}}$ adjustment do not have much impact on the power. This is probably due to the space of \mathbf{r}_i of the overall covariance matrix in most practical functions. The form \mathcal{F} $\overline{\mathcal{M}}$ of the computational burden of doing such responses it is probably not worthwhile to be worthwhile to be a set incorporate spatial correlation under indication under item of a high correlation of \mathbf{r}_i $\log a$ and $\sqrt{a^2 + 4a^2 + 4a^2 + 4}$

While incorporation in correlation in the international correlation in the important to voice in the important to vo \mathbf{a} thresholding rules, note that the notation of apply to cluster thresholding methods, and \mathbf{a} where $\begin{bmatrix} 1 & 0 \end{bmatrix}$ priori cluster size is also used to set the threshold. In this case, spatial correlation of the threshold. In this case, spatial correlation of the threshold. In this case, spatial correlation of \overline{a} . [يعيش براز يعرب وجديد مع مع جميع حيث ويعدل أن يورك المجمع المعدل المجمع المعدل المجمع الم

$$
[a e y] = 3y3]3q3q. a [y + 4q. q e y - 3q. [a 3 e y - 3aq, t y3]3q3q. y3e yq. 3e yq. 3e yq. 3e yq. 3e yq. yq. 3e yq. yq. 3e yq
$$

- 1. Bandettini, P.A., Jesmanowicz, A., Wong, E.C., and Hyde, J.S. (1993). Processing strategies for time-course data sets in functional MRI of the human brain. λ *Medicine*, **30:** 161-173.
- 2. Benjamini, Y. and Hochberg, Y. (1995). Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing. $\Box r$ $S_{t=1}$ $S_{t=1}$ $S_{t=1}$ $B_{t=1}$ 289-300.
- 3. Benjamini, Y. and Hochberg, Y. (2000). On Adaptive Control of the False Discovery Rate in Multiple Testing with Independent Statistics. *In* the end of $E = r$ *Statistics*, **25:** 60-83.
- 4. Benjamini, Y. and Yekutieli, D. (2001). The Control of the False Discovery Rate in Multiple Testing under Dependency. A S_i , S_i , **29:** 1165-1188.
- 5. Cox, R.W., Jesmanowicz, A., and Hyde, J.S. (1995). Real-time functional magnetic resonance imaging. ϵ ϵ ϵ , **33:** 230-236.
- 6. Friston, K.J., Frith, C.D., Liddle, P.F., and Frackowiak, R.S.J. (1991). Comparing functional (PET) images: the assessment of significant change. $\sigma r = C \cdot r \cdot B$ *Metabolism*, **11:** 690-699.
- 7. Friston, K.J., Worsley, K.J., Frackowiak, R.S.J., Mazziotta, J.C., and Evans, A.C. (1994). Assessing the significance of focal activations using their spatial extent. \boldsymbol{H} \boldsymbol{B} *ping*, **1:** 214-220.
- 8. Genovese, C.R., Lazar, N.A., and Nichols, T. (2002). Thresholding of Statistical Maps in Functional Neuroimaging Using the False Discovery Rate. *r*, **15:** 772-786.
- 9. Holmes, A.P., Blair, R.C., Watson, J.D.G., and Ford, I. (1996). Nonparametric Analysis of Statistic Images from Functional Mapping Experiments. *Jr Cr r B Metabolism*, **16:** 7-22.
- 10. Locascio, J.J., Jennings, P.J., Moore, C.I. and Corkin, S. (1997). Time series analysis in the time domain and resampling methods for studies of functional magnetic resonance brain imaging. $\boldsymbol{\mu}$ \boldsymbol{F} $\boldsymbol{\mu}$ $\boldsymbol{\$
- 11. Petersson, K.M., Nichols, T.E., Poline, J.-B., and Holmes, A.P. (1999). Statistical limitations in functional neuroimaging II. Signal detection and statistical inference. *p_{pi}rans R* Socc *Lond B Biol Sci*, **354:1387** 1261-1281.
- 12. Rowe, D.B. (2003). Multivariate Bayesian Statistics, CRC Press, Boca Raton, FL, USA.
- 13. Storey, J.D. (2001a). A New Approach to False Discovery Rates and Multiple Hypothesis Testing, Technical Report No. 2001-18, Department of Statistics, Stanford University.
- 14. Storey, J.D. (2001b). The False Discovery Rate: A Bayesian Interpretation and the q -value, Technical Report No. 2001-12, Department of Statistics, Stanford University.
- 15. Storey, J.D. and Tibshirani (2001). Estimating the positive False Discovery Rate Under Dependence, with Applications to DNA Microarrays, Technical Report No. 2001-28, Department of Statistics, Stanford University.
- 16. Worsley, K.J., Evans, A.C., Marrett, S. and Neelin, P. (1992). A three-dimensional statistical analysis for CBF activation studies in human brain. *In Crr B Metabolism*, **12:** 900-918.
- 17. Yekutieli, D. and Benjamini, Y. (1999). Resampling-based false discovery rate controlling multiple test procedures for correlated test statistics, \mathcal{F} $S_{\mathcal{F}}$ \mathcal{F} \mathcal{F} *Inference*, **82**, 171-196.