11th Annual OHBM Meeting

Abstract Number: 678
Last Modified: 10 Jan 05

Submitted By: Lee Friedman

Field-Strength and Scanner Vendor Effects on the Degree of Temporal Autocorrelation in fMRI Timeseries

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Objective: There is an increasing awareness of the need to account for temporally autocorrelated residuals in fMRI timeseries analysis. The necessity for this is dependent on the strength of the autocorrelations. In the present study, we report that the intensity of temporal autocorrelations is a function of scanner field-strength and also scanner vendor (GE vs Siemens).
Methods: Five volunteers traveled to 10 sites (Table 1) and were scanned on 2 days. The analysis was based on the 'sensorimotor' task (Gary Glover), which employed a block design, and involved bilateral alternating finger tapping at 3Hz in synchrony with 3Hz tones accompanied by a 3Hz flashing checkerboard. The blocks consisted of a control condition (stare at a fixation cross, 15 seconds) alternating with 15 seconds of activity. A run consisted of 7.5 blocks, and 85 3 second TRs. There were 4 runs per subject visit.
-----The fMRI data were preprocessed with AFNI. For statistical analysis, we employed Worsley's FMRISTAT package. A hemodynamic response function (HRF) was fit to each study using deconvolution. EPI timeseries were regressed onto the HRF, and residuals produced. The correlation structure among these residuals was modeled as an autoregressive process of degree 3. At each voxel, the autocorrelation was estimated using the Yule-Walker equations. Although this produced estimates for three lags, here we report only on Lag1 (t_0 vs t_{+1}). Autocorrelation estimates were averaged across two square ROIs (left and right, 5x5 voxels, 17.2mm^2) individually placed over each subject's motor cortex activation.
-----**Statistical Analysis:** The Pearson correlation coefficients were converted to a linear scale [i.e., effect size (Cohen's d), $d = 2*r/\sqrt{(1-r^2)}$] prior to analysis. They were converted back to correlations for presentation. Measures were analyzed using a Mixed Model ANOVA, with either Field-Strength (FIELD) and VENDOR (GE vs Siemens) or SITE as fixed effects and subject as a random effect.
Results & Discussion: Lag1 autocorrelations varied significantly across sites (Figure 1, black bars: low-field scanners, open bars: high-field scanners). For example, all three Non-GE low-field scanners (UCSD, NMEX, UCIR) had Lag1 autocorrelation values that were not significantly different from 0.0. On the other hand, low-field GE sites and all high-field sites had Lag1 autocorrelation values that were significantly greater than 0.0). All the high-field scanners had much stronger autocorrelations than the low-field scanners (Figure 1). There was a very strong statistically significant effect of FIELD and also a FIELD-by-VENDOR interaction (Figure 2): Low-field GE scanners had stronger temporal autocorrelation than low-field Siemens scanners, but the vendors did not differ at high field.
Conclusions: Scanners differed markedly in the intensity of autocorrelation present in fMRI timeseries. High-field scanners have significantly more intense Lag1 autocorrelation than low-field scanners. Among low-field scanners, GE scanners have significantly higher temporal autocorrelation than Non-GE scanners. These results highlight the need to account for temporal autocorrelation in fMRI analysis, especially in the context of multi-center studies, which include low- and high-field scanners and scanners from multiple vendors.
References & Acknowledgements: Acknowledgements: Supported by grant [#5MOIRR000827] to the FIRST Biomedical Informatics Research Network, NIH-NCRR.

Table 1: Description of hardware and sequences of the nine sites (10 scanners)

Center	Abbreviation	Field Strength	Manufacturer	RF coil type	Functional sequence
Brigham & Women's	BWHM	3.0T	GE	GE TR Research Coil	EPI

Duke/UNC	D40T	4.0T	GE Nvi LX	TR quadrature head	Spiral
Duke/UNC	D15T	1.5T	GE Nvi LX	TR quadrature head	Spiral
Univ. Iowa	IOWA	1.5T	GE Signa CV/i	TR quadrature head	EPI
Mass. General Hospital	MAGH	3.0T	Siemens Symphony Trio	TR quadrature head	EPI -Dual Echo
Univ. of Minnesota	MINN	3.0T	Siemens Symphony Trio	TR quadrature head	EPI
Univ. New Mexico	NMEX	1.5T	Siemens Sonata	RO quadrature head	EPI
Stanford Univ.	STAN	3.0T	GE CV/NVi	Elliptical quadrature head	Spiral in/out
Univ. of California, Irvine	UCIR	1.5T	Philips/Picker	RO quadrature head	EPI
Univ. of California, San Diego	UCSD	1.5T	Siemens Symphony	TR quadrature head	EPI

FIGURE 1 - Temporal Autocorrelation - Lag 1

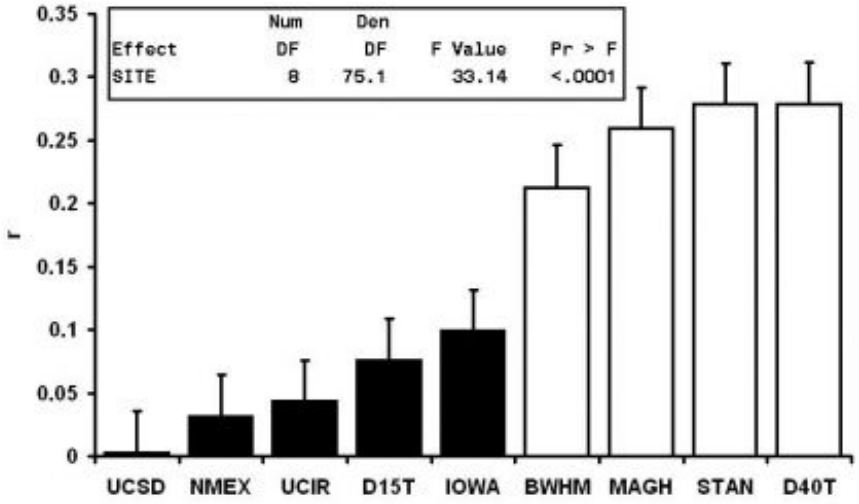
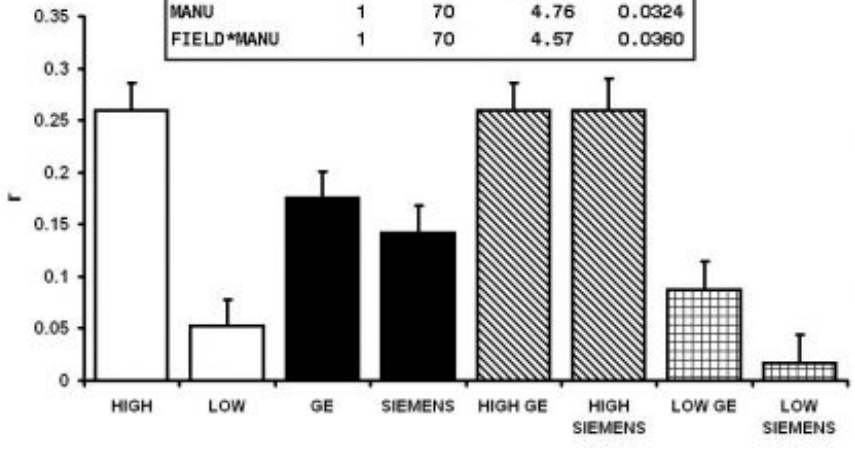


FIGURE 2 - Temporal Autocorrelation - Lag 1

Effect	Num DF	Den DF	F Value	Pr > F
FIELD	1	70	179.39	<.0001
MANU	1	70	4.76	0.0324
FIELD*MANU	1	70	4.57	0.0360



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