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Isolated Spike-like Transients (ISLTs) in Functional MR Timeseries: Evidence for Vendor and Field Strength Effects on Rates

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Objective: Most statistical models of fMRI data are very sensitive to extreme outliers. We have noticed isolated, spike-like transients in fMRI timeseries that, from a statistical point of view, constitute outliers. We have found vendor (Siemens vs GE) and field-strength effects on the rate of occurrence of these events.

Methods: Five healthy normal volunteers traveled to 9 sites (10 scanners). The analysis is based on a single activation task, i.e., the 'sensorimotor' task, as designed by Dr. Gary Glover. The task employed a block design, and involved bilateral alternating finger tapping at 3Hz to a 3Hz set of tones accompanied by a 3Hz flashing checkerboard.

-----All sites used a bite bar for head restraint. Sites employed scanners from 3 vendors [GE (n=5), Siemens (n=4) and Picker (n=1)]. Half of these scanners operated at low field (1.5T, n=5) and half at high field (3.0T, n=4, 4.0T, n=1).

-----ISLTs were detected on unprocessed images, using the AFNI program 3dToutcount (http://afni.nimh.nih.gov/afni/AFNI_Help/3dToutcount.html). The timeseries was detrended with a 2nd order polynomial using L1 norm regression. The median absolute deviation of the time series minus the trend was computed. The degree of deviance of an outlier is defined by its 'q' value, which is analogous to a p-value in least squares (L2 norm) regression, and is an index of the probability that an event occurred by chance. We counted ISLTs with $q = 0.00000000000001$ (1.0E-14). The ISLT in Figure 1 and Figure 2 has a $q=1.0E-12$.

-----ISLTs at both thresholds were counted for all 5 subjects at 10 scanners for two sensorimotor task runs for two visits (200 observations total). Each sensorimotor task consisted of 85 TRs, with TR=3.0 sec, or 4.25 min.

-----Statistical Analysis: The ISLT counts were converted to ranks, and were analyzed with ANOVA (Conover, 1971). Residuals were normally distributed.

Results & Discussion: Although we have not completed a detailed analysis of the distribution and nature of the ISLTs, these events appear to be more likely in areas of high susceptibility artifact. They also frequently occur near edges or in a bright voxel near a dim voxel. However, ISLTs do occur in the parenchyma away from susceptibility artifact (Figure 1).

-----The median frequency of occurrence, as well as the 25th and 75th percentile frequency for both thresholds, are presented in Table 1. The mean ranks of the frequencies of ISLTs are graphed for each scanner in Figure 3, segregated by vendor (Siemens vs GE) and field-strength (Low vs High) (bars are standard errors).

-----ISLTs: Figure 3 suggests both vendor and field effects. The results of the ANOVA test (Table 2) support this. There was no field-strength by vendor interaction. The vendor effect was by far the largest effect (approximately 6 times larger F-value than the field-strength effect).

Conclusions: ISLTs are present in fMRI timeseries and need to be taken into account during analysis. Further characterization of these ISLTs will be important to understand their cause.

References & Acknowledgements: References: Conover, W.J. (1971): Practical nonparametric statistics. Wiley, NYC.

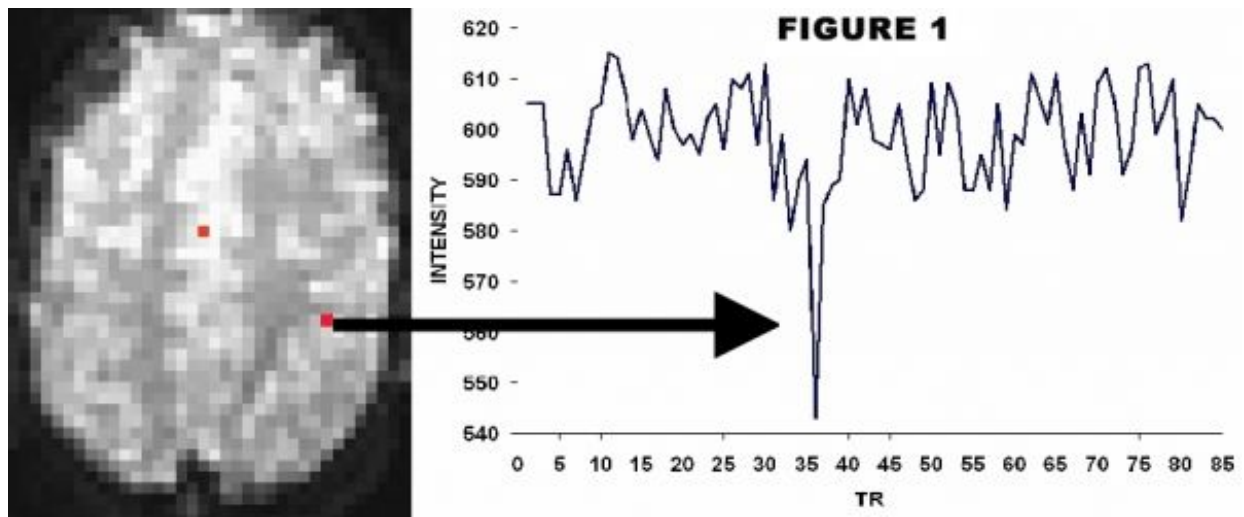


FIGURE 2 ISLT Occurrence by Field-Strength and Vendor

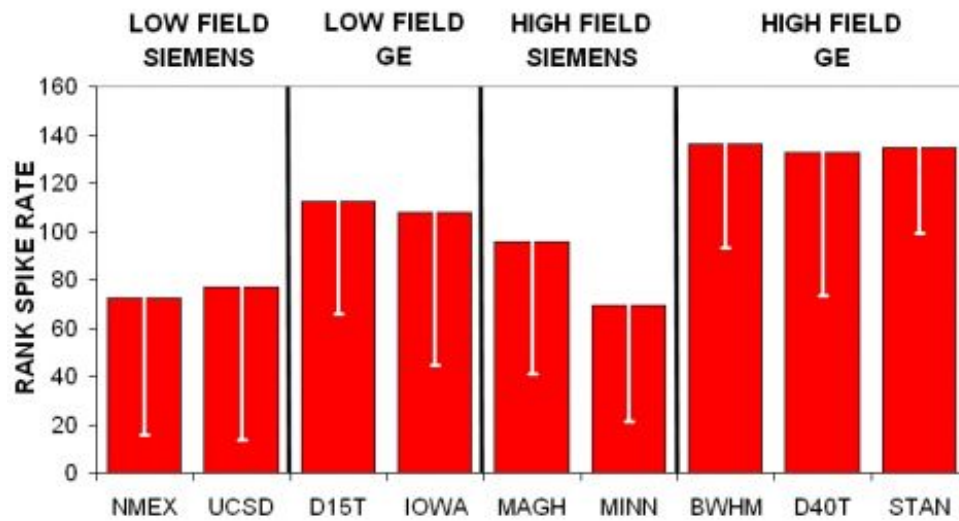


TABLE 1	Number of ISLTs
25th Percentile	10
Median	59
75th Percentile	233

TABLE 2	df	F	Sig.
FIELD	1, 176	4.4	0.037
VENDOR	1, 176	28.3	<0.00001
FIELD * VENDOR	1, 176	0.7	0.39

