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## Scanner and Field-Strength Effects on the Shape of the Hemodynamic Response Function

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**Objective:** The shape of the hemodynamic response function (HRF) is thought to reflect cerebrovascular and hemodynamic characteristics of individuals. We present data that the shape of the HRF is also a function of the scanner in which it is measured and, for some measures, specifically a function of the field-strength of that scanner.

**Methods:** Five volunteers traveled to 10 sites (Table 1) and were scanned on 2 different days. 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 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 despiked, motion corrected and detrended using AFNI. HRFs for each study were deconvolved using Worsley's FMRISTAT fMRI statistical package (<http://www.math.mcgill.ca/keith/fmristat>).

-----The estimated HRFs, which were evaluated at a 3 second temporal resolution, were scaled to an amplitude range of 0.0 to 1.0 (arbitrary units). A 7th order polynomial was then fit to the scaled HRFs to allow for a temporally continuous analysis. Four measures were extracted from each HRF function (Figure 1): (1) T\_Rise = time to achieve 0.5 amplitude on the upslope, (2) T\_Fall = time to achieve 0.5 amplitude on the downslope; (3) FWHM = T\_Fall-T\_Rise, (4) T\_Peak: The time to peak.

-----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).

-----**Statistical Analysis:** All measures were analyzed using a Mixed Model ANOVA (SAS PROC MIXED), with Field-Strength (FIELD) or SITE as fixed effects and subject as a random effect.

**Results & Discussion:** Figure 1 shows the overall average HRF. T\_Rise varied significantly by site ( $p < 0.0001$ , 1.67 to 4.36 sec)(Figure 2, high-field scanners shown in black) and by field-strength ( $p = 0.0004$ ). T\_Fall also varied significantly by site ( $p < 0.0001$ , 18.93 to 22.54 sec) and field-strength ( $p = 0.0038$ )(Figure 3). There was also SITE effects for FWHM ( $p < 0.0001$ ) and T\_Peak ( $p = 0.03$ ), but no effect of FIELD on these measures. Mean site HRFs from two distinctive sites (IOWA and STAN) are shown for comparison in Figure 4.

**Conclusions:** These scanner and field-strength effects are unexpected and indicate that the HRF is a function of both the person and the machine. The significant SITE effects highlight the importance of fitting individual HRFs in multi-center studies. The fact that HRFs from high-field scanners rise and fall more quickly may be a reflection of the increased contribution of signal from capillaries (upstream) versus venules and veins at high-field (Urgurbil et al., 1999).

**References & Acknowledgements: References:** Urgurbil 1999. Imaging brain activity using nuclear spins. In: Magnetic Resonance and Brain Function: Approaches from Physics IOS Press; Amsterdam, 261-310.

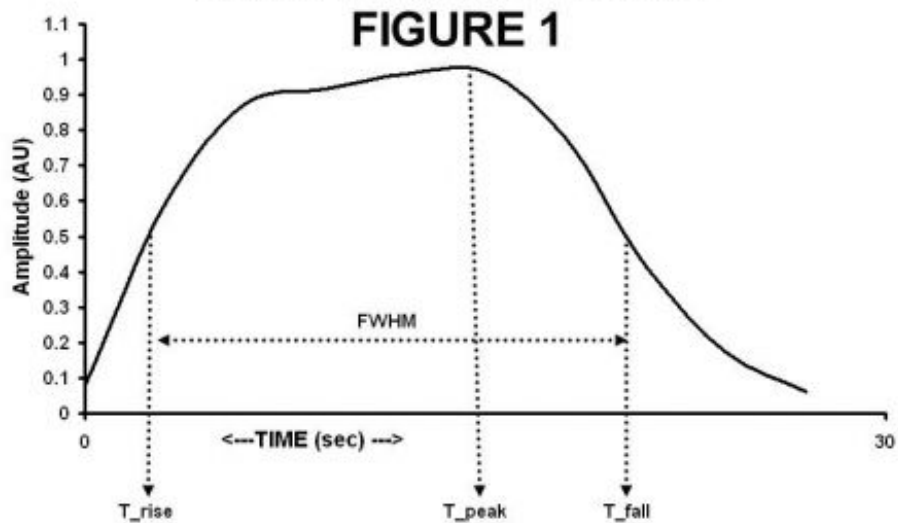
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Table 1: Description of hardware and sequences of the nine sites (10 scanners).

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

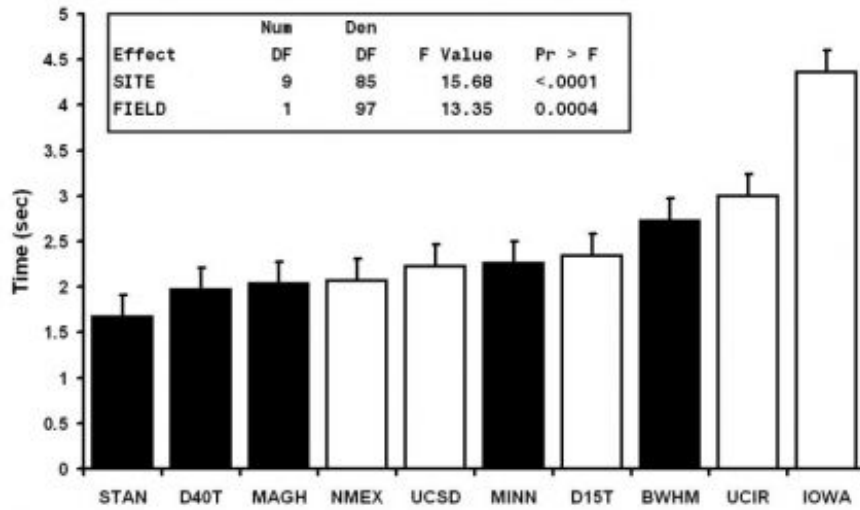
Duke/UNC	D40T	4.0T	GE Nvi LX	TR quadrature head	Spiral
Duke/UNC	D15T	1.5T	GE Nvi LX	TR quadrature head	Spiral
Univ. Iowa	IOWA	1.5T	GE Signa CV/i	TR quadrature head	EPI
Mass. General Hospital	MAGH	3.0T	Siemens Symphony Trio	TR quadrature head	EPI -Dual Echo
Univ. of Minnesota	MINN	3.0T	Siemens Symphony 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

FITTED HEMODYNAMIC RESPONSE FUNCTION



**FIGURE 2**

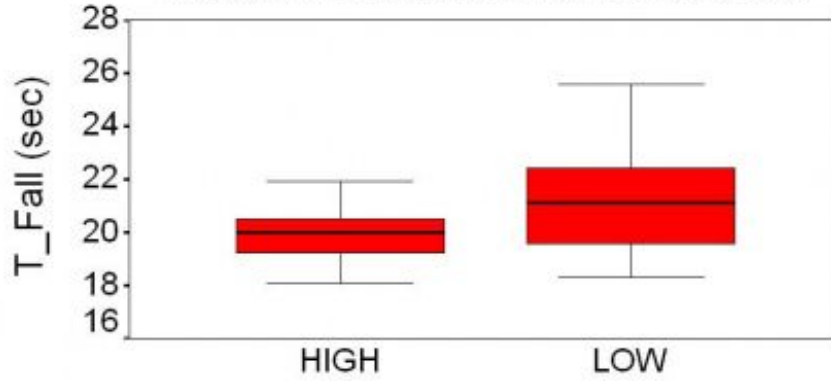
T\_Rise



**FIGURE 3**

T\_Fall:

Comparison of High and Low Field Scanners



F(FIELD) = 8.81, df = 1,96, p = 0.0038

HRFs From Iowa and Stanford

**FIGURE 4**

