Psy 8960 – fMRI: Hands-on Training
Fall Semester, 2006

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Course Description

Course goals. By the end of the semester, students will:

- be comfortable with the hardware and software in the MR environment, to ensure safe operation and selection of the right equipment for a given experiment.
- be acquainted with the fundamental physical principles behind magnetic resonance imaging
- understand the possible types of image contrast, and their uses in neuroscience
- be adept at modifying pulse sequence parameters to balance the inevitable trade-offs between signal-to-noise ratio, resolution and acquisition time.
- know how to modify an experimental protocol to minimize the impact of distortion and signal loss due to magnetic field inhomogeneities.

Logistics. The class will meet Wednesdays from 3 – 4 pm and Fridays, 3 – 5 pm at the Center for Magnetic Resonance Research in Room 107 (Wednesdays) and at the 3T Scanner (Fridays). Format is lecture and group discussion. Assignments and supplementary materials will be posted on the course website: http://vision.psych.umn.edu/~caolman/courses/Fall2006.

Grading and Attendance policies

The course is offered for three credits, graded on an A-F basis (A: 93 – 100, A-: 90 – 92, B+: 88 – 89 …, C-: 70 – 72; students taking the course pass/fail will receive an S (satisfactory) for grades higher than D+.)

- Attendance and participation (including submission of bi-weekly assigned exercises) will constitute 70% of the grade.
    - 30% of the course grade will be based on bi-weekly assignments, which will be given full credit if completed and turned in on time. Arrangements for submitting late assignments must be made before the due date to receive partial credit for the assignment.
    - 40% of the course grade will be based on an attendance sheet that will be passed around at every class period. Excused (pre-arranged or sick) absences will be counted as attendance.
- A mid-term exam will constitute 15% of the grade.
- A final exam will constitute 15% of the grade.

Lectures and background readings

The course is divided into 6 modules, each lasting two weeks and covering one topic. Lectures will be informal and brief, focusing on the particular images acquired in lab and simulation during that module. Background readings will be selected from the following texts, and made available a week before the start of the module, whenever possible. Readings will be drawn primarily from the following three texts:

- Introduction to Functional Magnetic Resonance Imaging: Principles and Techniques by Richard B. **Buxton** (Cambridge University Press, Cambridge, UK, 2002)
- Magnetic Resonance Imaging: Physical Principles and Sequence Design, by E. Mark **Haacke**, Robert W. Brown, Michael R. Thompson, and Ramesh Venkatesan (John Wiley & Sons, Inc., New York, NY 1999).
- Functional Magnetic Resonance Imaging, by Scott A. **Huettel**, Allen W. Song, Gergory McCarthy (Sinauer Associates, Inc., Sunderland MA, 2004).

Weekly assignments

Short problem sets will be handed out every other week and due two weeks later. They are designed to provide concrete instantiations of the material covered in the lecture and lab, and will vary in format: short-answer, multiple choice, matching, calculation and/or data simulation/analysis. Matlab™-based simulations and demonstrations will be used heavily in lecture and assignments.

Mid-term and Final exams

Both mid-term and final exams will each consist of three multi-part questions, one for each module covered in the 1st (midterm) and 2nd (final) half of the semester. Exams will be open book, but will be short answer and require only pen and paper to complete. Format will vary, but will include matching images to pulse sequence diagrams, describing the origins of depicted artifacts, and providing brief definitions of technical terms.

Date	Module	Description
Sep 6	Introduction	Nuclear Magnetic Resonance and Radio Frequency
Sep 8		Safety in a high-field environment. Scanner start-up and shut-down.
Sep 13	General Imaging	Gradients
Sep 15		Lab/Sim 1: FLASH imaging (FOV, resolution, k-space)
Sep 20		Fourier transforms
Sep 22		Lab/Sim 1: FLASH imaging (FOV, resolution, k-space)
Sep 27	Image contrast	T_1 and T_2
Sep 29		Lab/Sim 2: TSE imaging (PD, T_1 and T_2 images)
Oct 4		TR and TE
Oct 6		Lab/Sim 2: TSE imaging (PD, T_1 and T_2 images)
Oct 11	Fast imaging	EPI
Oct 13		Lab/Sim 3: GE and SE EPI sequences
Oct 18		Spiral
Oct 20		Lab/Sim 3: GE and SE EPI sequences
Oct 25	Time vs. SNR	Noise
Oct 27		Lab/Sim 4: EPI sequence, low and high bandwidth
Nov 1		Bandwidth
Nov 3		Lab/Sim 4: EPI sequence, low and high bandwidth
Nov 8	Distortion	Fieldmaps
Nov 10		Lab/Sim 5: FLASH and EPI images of an air bubble
Nov 15		Distortions
Nov 17		Lab/Sim 5: FLASH and EPI images of an air bubble
Nov 22	Special topic	T.B.D.
Nov 24	(No class)	(Thanksgiving holiday)
Nov 29	Drop-out	Through-slice dephasing
Dec 1		Lab/Sim 6: Signal loss; distortion/drop-out trade-off
Dec 6		Thin slices
Dec 8		Lab/Sim 6: Signal loss; distortion/drop-out trade-off
Dec 13	Special topic	T.B.D.
Dec 15		Final exam (due)