Cross modal activations in hMT+ and the influence of auditory motion on the perception of visual motion in a sight recovery subject.

**Methods:**

Subjects

MM lost all but low light perception at age three. Following a corrective surgery at age 46, MM re-acquired vision. At the date of testing MM’s sight had been restored (20/1000, limited by severe amblyopia rather than optics) for 17 years. Despite severe losses in acuity, MM has no known deficits in his ability to process visual motion; MM reports continued use of visual motion information in everyday life, and shows robust hMT+ responses to visual motion[CIT].

MM (age 63) and two controls (aged 50 and 48) participated in both the behavioral and fMRI portions of the experiment. Both controls had normal or corrected-to-normal vision in each eye and reported no problems with hearing in either ear. All procedures, including recruitment, consenting, and testing followed the guidelines of the University of Washington Human Subjects Division and were reviewed and approved by the Institutional Review Board.

Visual acuity matching

To match the control subject’s visual input to MM’s low visual acuity, control subjects viewed all stimuli blurred to match MM’s spatial contrast sensitivity by taking the FFT of the stimuli and attenuating frequency components commensurate with MM’s contrast sensitivity function {CSF}, which resulted in blurred stimuli lightly larger and with a lower center luminance than the unblurred versions. All stimulus parameters will be given for the unburned versions.

MM’s CSF was acquired on the experimental display in a darkened room, calibrated using a PR-650 spectroradiometer (Photo Research, CA) and linearized using custom software written in Matlab. The monitor had a peak luminance of ###cd/m^2 and a black level of ### cd/m^2, and the screen subtended 59-by-33 degrees of visual angle at a viewing distance of 57 cm. Vertical gratings occupying the central 33° of the display were sinusoidal modulations around an average gray level. Over four trials, gratings with spatial frequencies of 0.25°, 0.3536°, 0.5°, 0.7071°, 1.0°, and 2.00 °were sequentially to MM under stationary free viewing conditions. MM adjusted the contrast between 0 {uniform gray} and 1 for each grating until it was no longer visible; these numbers were averaged to obtain the mean set contrast for each spatial frequency. {Should I include calculating sensitivity, mean sensitivity?}

Stimuli and procedure

Psychophysics

Stimuli were presented on an ASUS PB278Q at 2560 x 1440 at a viewing distance of 50 cm, and generated using MATLAB and psychophysics toolbox.

The stimuli and presentation were substantively similar to those described by [http://www.sciencedirect.com/science/article/pii/S0042698903007594], consisting of moving white dots on a black background. The dots appeared within a window subtending 15h x 16v° of visual angle. Each dot {60/field} subtended 2.1° and moved along a single vector at a rate of 25 deg/sec. Stimuli were presented at 59.9571 frames per second, and each dot had a “lifetime” of 36 frames, at which point it was immediately moved to a random location within the field. At stimulus onset each dot began at a random location and a random point in its 36 frame lifetime. If a dot’s path extended beyond the aperture within its lifetime it was randomly replaced somewhere within the aperture as a new dot. The center fixation spot consisted of red square annulus subtending 2.2° within a black “mask” region which subtended 6°, separating central fixation from the moving dots.

Each trial contained both signal and noise dots in varying proportions according to the trial’s ‘coherence level’. Signal dots moved either left or right, depending on the trial, while noise dots each traveled along a randomly determined vector between 0° and 360°. Thus, with a field of 60 dots a “left” trial at 50% coherence would have 30 dots moving left and 30 along 30 random vectors.

During each trial, subjects were presented with simulated auditory motion presented through Sennheiser HD 600 headphones. The motion cue consisted of a ?? centered around ## Hz. Auditory motion was simulated by the addition of inter-aural time delay, inverse square attenuation, Doppler shift, and simulated head shadow. The auditory cue could run either congruent or incongruent with the direction of the dots.

Each run consisted of 60 trials at one of 8 coherence levels. To avoid over-sampling coherence levels at which subjects performed at ceiling or change, the coherence was varied trial by trial to cover the range between performance at chance and perfect performance, which varied from subject to subject. The exact sequence of the 8 coherence levels and the direction of the dots was determined by randomly selecting one of 10 pre-generated lists, while the direction of auditory motion was determined uniquely for each trial, and balanced for each coherence level and direction of visual motion.

fMRI

Stimuli were back-projected onto a display using a XXXX###XXX projector, visible to the subject via angled mirror. The screen was 36.5cm away from the subject’s eyes, measured 27.5 cm wide, and was run at a resolution of 800x600 pixels. Auditory stimuli were presented via S14 Sensimetrics MR safe stereo earbuds. Volume was set by the subject to be near the top of their comfortable listening level, and adjusted up or down after the first run, as requested.

Stimuli were similar to those described above, with the following differences: the stimulus aperture subtended 20x20°, the fixation target was white and subtended 1.5°, and the fixation mask subtended 2°; each field contained 80 dots moving at 10deg/sec with a lifetime of 30 frames, with each field displayed for .4625s {2 presentations per TR}. Dots were perfectly coherent, with the entire field moving either straight left or right, depending on the trial. Auditory stimuli were ?? with a center frequency of 1000hz and a width of 1000hz.

During a single presentation visual and auditory stimuli could move in the same direction {coherent} or in opposing directions {incoherent}, and could occur simultaneously {in phase} or offset by 0.##s {out of phase}. Additionally, blank screens, visual only and auditory only trials were included. The event sequence was randomized for each run. Four times per run the dots would appear at half their usual luminance. Subjects were instructed to attend to the stimuli while maintaining fixation, and report these dimming events. Subject event reporting was used to confirm subject attentiveness during each scan.

Scanning was performed using a 3 T Allegra scanner with a 32-channel head coil at the Diagnostic Imaging Sciences Center at the University of Washington. High-resolution T1-weighted MPRAGE images were collected in 128 sagittal slices with 1mm isotropic voxels (TR=#.#ms; TE=#.#ms). Blood-oxygen level dependent (BOLD) images were acquired with a gradient-echo EPI sequence: TR=2000ms; TE=##ms; flip angle = ##°; field of view = ### × ###; voxel size 3mm isotropic. The acquisition window was positioned off axial to include the temporal and occipital lobes

Data Analysis

Analysis of fMRI data was carried out using {#whatever Fang is using#}.

Behavioral data were analyzed using custom code written in MATLAB. More here as this continues,