Background: Pupillary dilatation has been used as a robust measure of cognitive processes, and associated neural pathways are well understood. However, brain regions responsible for dilatation from non-visual stimuli are unexplored. We used a method involving fusing fMRI and pupil response data to identify areas implicated in the pupil response.

Methods: We tested 19 healthy control subjects (ages 18-49, 37% male) using BOLD fMRI (TR=1500ms) in a Siemens Allegra 3T magnet while simultaneously collecting pupillary data using an ASL model 5000 eye-tracker. Subjects performed an auditory oddball task consisting of 10% target, 10% novel, and 80% standard tones. They pressed a button to respond only to target tones. fMRI data were realigned, normalized, smoothed, and statistics were generated using the general linear model. Pupil response data were processed by removing blinks, and averaging the time courses surrounding the button presses. The fMRI and pupil data for all subjects were entered into the Fusion ICA Toolbox (FIT, Calhoun et al), and statistics were generated for the correctly identified target condition.

Results: Pupil response averages showed dilatation of 0.203mm for targets, 0.08mm for novels, and 0.006 for standards. Fusion analysis produced one component for target tones and one for novels. Fusion of target fMRI and pupil diameter showed significant mutual information in the parahippocampal gyrus and midbrain [$p<0.05$ uncorr]. Fusion of novels produced no significant mutual information.

Conclusions: Our data suggest that the parahippocampal gyrus, known to activate during memory retrieval and recognition, activates concomitant with pupil dilatation.