The Brain Organization of Perception in Chess Experts

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ABSTRACT
Chess experts possess an exceptional ability to perceive complex patterns in chess game boards. This enables chess experts to perceive distinct groupings of chess pieces as chunks or configural units. It has remained unclear what regions of the brain enable configural units to be perceived by experts relative to other visual categories of expertise (faces, scenes, common objects). We tested International Master and Grandmaster chess players (Elo Ratings Range: 2447-2564) on a 1-back visual recognition task in which subjects perceived real game chessboards, chessboards with randomly placed pieces, faces, outdoor scenes, and common objects in a fMRI block design experiment. Experts reported perceiving from one to three chunks, or configural groupings, in the chess board conditions. Functional MRI results indicate that expert perception in chess is organized differently at a neural level than expert perception of other visual categories.

OVERVIEW OF STUDY
*Chess ability is widely regarded as being at the forefront of human reasoning and intelligence.
*A Master player accumulates massive visual experience with configurations of chess pieces. Yet the brain organization of this perceptual expertise is currently unclear.
*The perception of human faces has been previously associated with brain activity in the fusiform gyrus which is also selectivity active when car experts and bird experts perceive cars and birds (Gauthier, Skudlarski, Gore & Anderson 2000).
*Chess allows a critical test for theories of visual expertise, as chess configurations, in the chess board conditions. Functional MRI results indicate that expert perception in chess is organized differently at a neural level than expert perception of other visual categories.
*The case that face-selective fusiform cortex can become adapted to chess perception, and other stimuli to determine whether chess and face perception activate common brain regions using functional MRI. We also compare activation to faces in chess-related areas.

METHODS
*Participants: 6 elite chess experts who rank within the top one percent of active tournament players (five International Masters and one Grandmaster). All were male.
*Chess expertise was substantiated by competitive ratings (Elo range = 2447-2583), years playing chess (M = 16 years), and tournament activity (M = 17 per year).
*Philips 3T MRI: EPI: TR=2000 ms, TE=28 ms, flip angle= 20 degrees, slices 3mm thick, 0.5mm slice gap
*T1-weighted images: TR=500ms, TE=10, slice thickness=4mm with no gap at a 90 degree flip angle.
*Analyses performed in SPM5 run in Matlab 6.5. EPI images were realigned and then smoothed with an 8 mm 3D Gaussian kernel. Block design analysis performed using GLM with regressors for each image type (faces, real game chess, random chess, scenes, objects) convolved with canonical HRF in SPM5.

EXPERIMENTAL TASK
*Chess experts viewed blocks of items and judged whether each was a repeat or new image. Images consisted of human faces, outdoor scenes, common household objects, chess boards from real games, and chess boards with randomly placed pieces that could not occur in real games (see figure). The experts indicated that they were able to perceive all or most of the chess boards within 2 seconds.

GROUP RESULTS

REGION OF INTEREST RESULTS
Face ROI Analyses (defined by faces minus scenes and objects contrast):
*Significant difference found in the right FFA (p(4, 20)=3.09, p=.03), the Left FFA (p(4, 25)=3.77, p<.001) and the Left OPA (p(4, 15)=3.21, p=.06).

Fusiform Face Area (FFA) Regions
*The Left FFA activation to faces was significantly greater than for chess, scenes and objects. The face and random chess comparison did not reach significance. In the right FFA, face activation was significantly greater than activation for chess, scene and objects. The comparison of face and random chess conditions did not reach significance corrected for multiple comparisons.

Occipital Face Area (OFA) Regions
*Right OFA selectivity for faces was smaller than for chess, random chess, scenes and objects. The left OFA showed greater activation for faces over chess and objects.

CONCLUSIONS
*While face and chess stimuli are thought to be processed configurally, we observed limited overlap in the neural regions supporting perception in faces and chess boards.
*Chess perception involved more of the parietal and occipital cortex than face perception at the group level.
*Face perception dominated over chess perception in the FFA and OFA regions.
*Chess perception dominated over face perception in the posterior cingulate
*Visual expertise may manifest itself in similar ways at a behavioral level, but similar neural regions need not govern the visual expertise. In this study a key difference between face and chess is that the level of recognition for specific items was likely higher for specific chess boards than for specific faces.

Acknowledgments: We thank Jim Stallings and the UT Dallas chess program for their help with the study. This work is supported by a UT Dallas Catalyst Grant.