

## 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 contrasts enabled us to identify face regions, scene regions, and areas involved in chess perception. Results revealed that chess experts showed greater activation for chess over other categories in the posterior occipital cortex, medial parietal cortex, and regions of the visual association cortex that did not overlap with face-selective and scene-selective regions. Additionally, the chess experts showed greater activation for real game chess board displays over randomly placed chess board displays in the medial and lateral occipital cortex. These findings reveal distinct brain regions associated with expert chess perception. Further, these 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 selectively 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 bear little featural or configural resemblance to faces, cars, or birds, and also lack biological characteristics. If chess experts process chess patterns similarly to faces, it would challenge the view that common visual or biological characteristics are necessary for different classes of stimuli to be perceived in the same manner.

\*The idea that face-selective fusiform cortex can become adapted to process chess patterns is a compelling one, and there have also been reports in the expertise literature that the fusiform areas may be involved in processing chess game patterns (Righi & Tarr 2004).

\*The present study addressed the central question of whether the fusiform gyrus supports chess expertise at an early perceptual level. We compared chess experts' brain activation to faces, chess boards, 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.

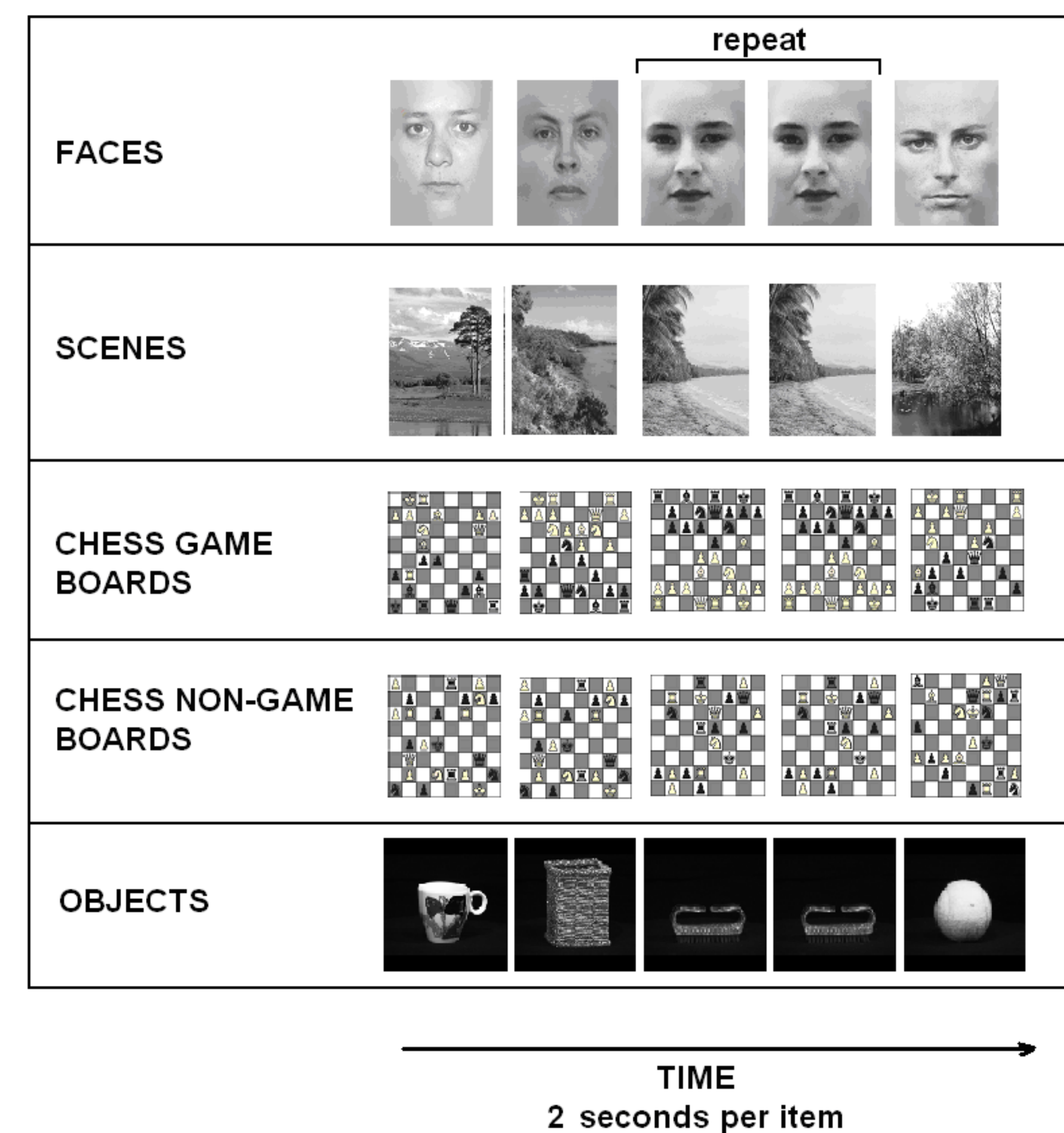
\*Chess expertise was substantiated by competitive ratings (Elo range = 2447-2583), years playing chess (M = 16 years), and tournament activity (M = 17 per year).

\*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.

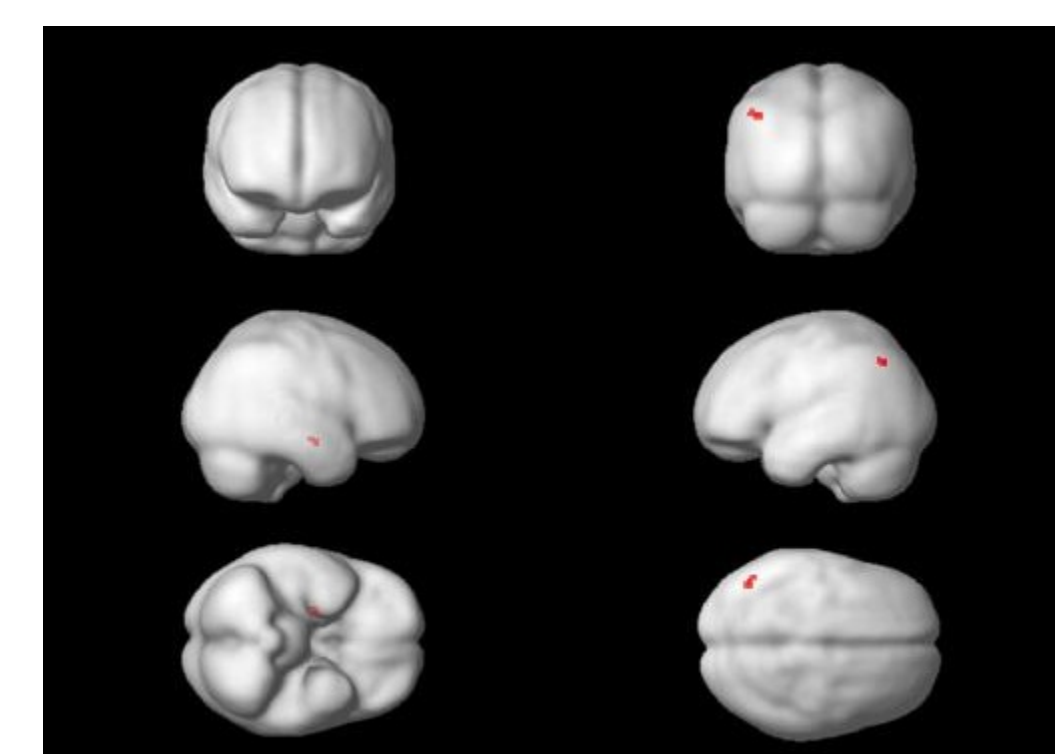
## EXPERIMENTAL TASK

\*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.

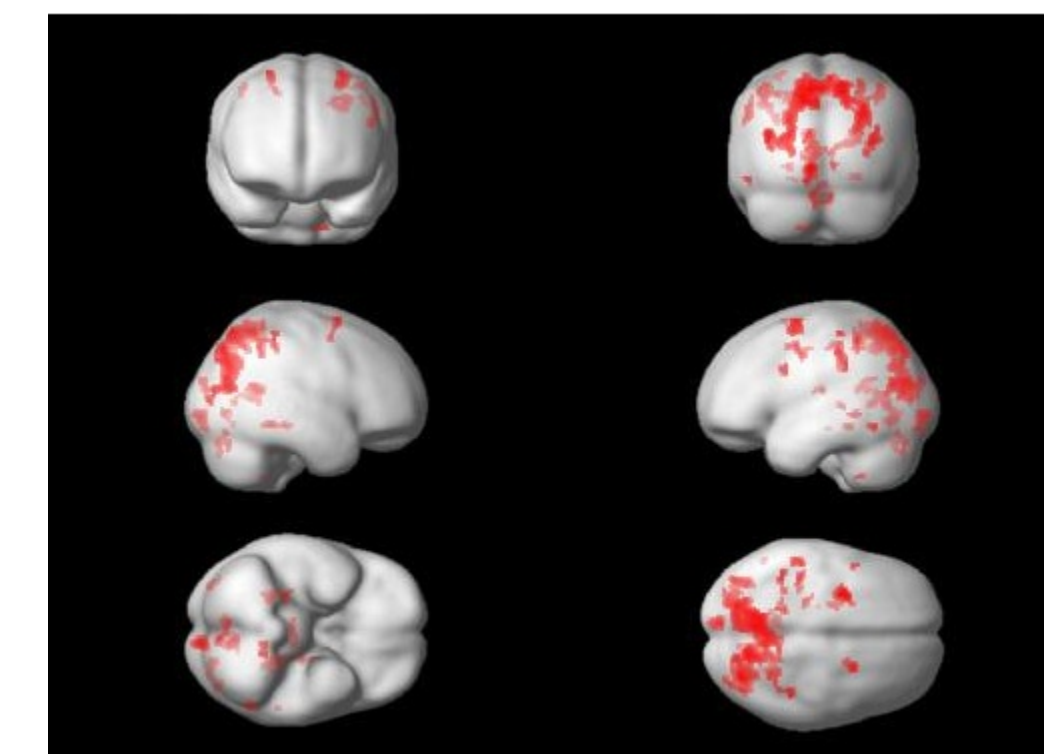


## GROUP RESULTS

### FACES > CHESS GAMES



### CHESS GAMES > FACES



At right: Group map showing subtraction of chess games from faces revealing right medial temporal lobe and left lateral parietal activation ( $p < .001$ , uncorrected).

At left: The reverse subtraction showed extensive parietal and occipital activation associated with perception of chess games over faces ( $p < .001$ , uncorrected).

## REGION OF INTEREST RESULTS

### Face ROI Analyses (defined by faces minus scenes and objects contrast):

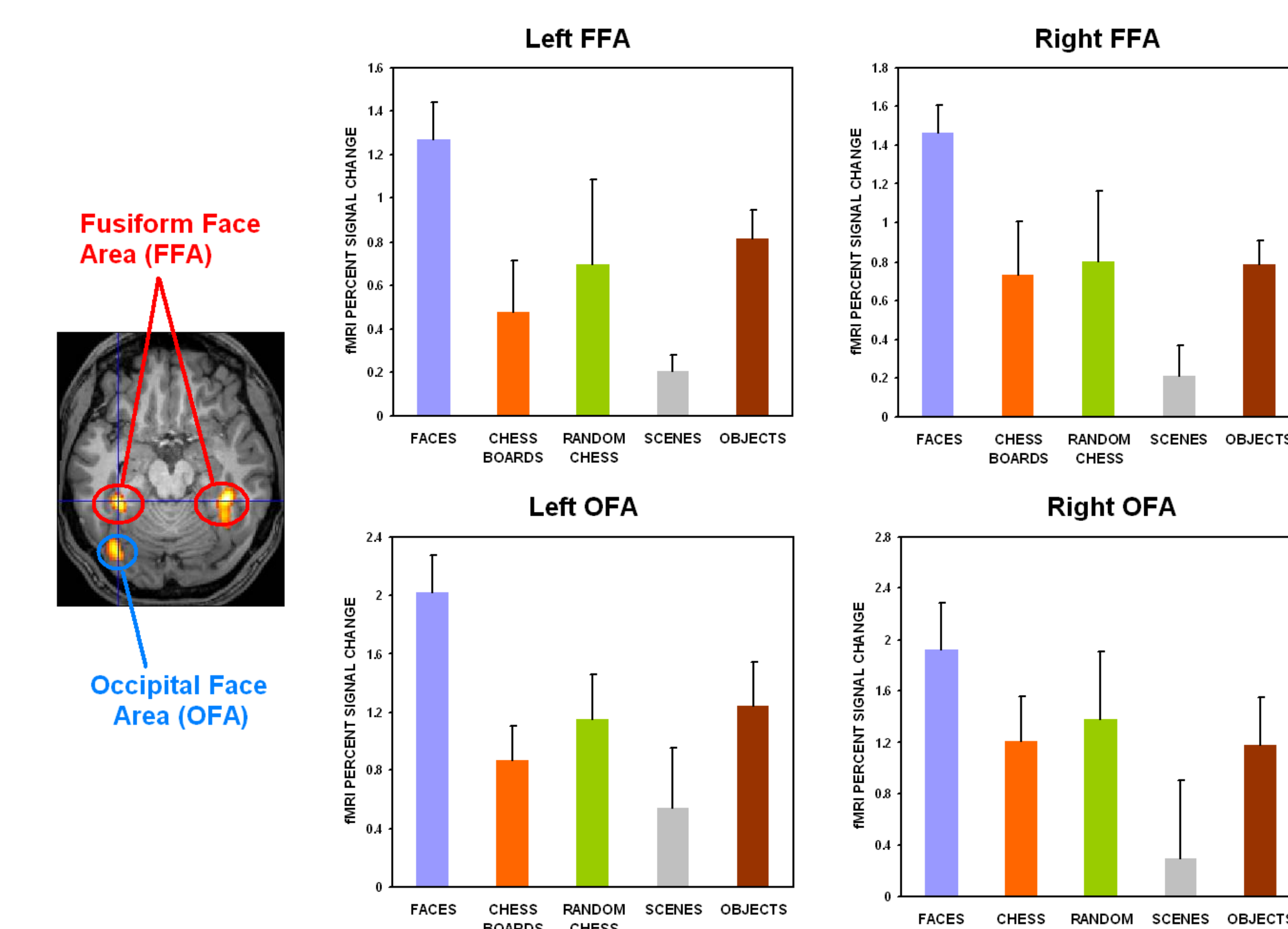
\*Significant differences were found in the Left FFA ( $F(4, 20)=3.09, p=.039$ ), the Right FFA ( $F(4, 25)=3.77, p=.016$ ) and the Left OFA ( $F(4, 15)=3.21, p=.043$ ).

### 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 face activation was significantly greater than for chess, random chess, scenes and the objects. The left OFA showed greater activation to faces over chess and objects.

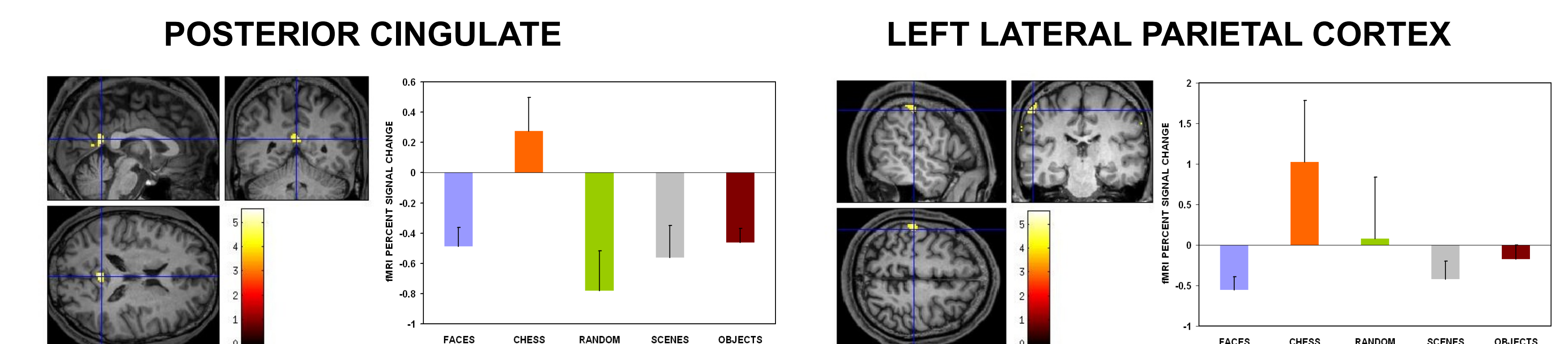


### Chess ROI Analyses (defined by real chess minus random chess contrast):

\*Significant difference found in the Posterior Cingulate ( $F(4, 20)=2.86, p=.01$ ). The left lateral parietal ROI did not result in a significant ANOVA difference, but showed evidence of chess selectivity.

### Posterior Cingulate ROI

\*The activation to real game chess was significantly greater than for faces, random game chess boards, and objects. The comparison of chess and scene conditions did not reach significance corrected for multiple comparisons.



## 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.