Brain Activation During Sexual Arousal in Healthy Heterosexual Males

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Introduction

Recent research has substantially increased our knowledge of the physiology of penile erection leading to important advances in the treatment of erectile dysfunction. Despite the role of the CNS as the "conductor" (1) of this complex process, little detail is known about brain activation, sexual interest, and sexual function. The only two previous brain activation studies investigating male sexual response used PET(2,3), in which frontal, temporal, cingulate, and subcortical structures were involved. Our goal was to evaluate brain activation during sexual arousal in healthy heterosexual males, and to correlate this with both subjective arousal as well as objective penile erection.

Methods

Subjects: 12 healthy heterosexual male subjects (ages 18-30) with normal sexual function were scanned after detailed questionnaire and telephone interview, which included the Erectile Function Questionnaire, Sexual Behavior Inventory, General Symptom Index of the SCL-90-R, Sexual Arousal Inventory, and previous sexual history and medication use. Extensive exclusion criteria were employed.

Stimulus Methodology: Two scans were presented to each subject, each lasting 15 minutes. In the first, subjects received alternating video clips of relaxing scenes, sports highlights (for non-erotic arousal), and sexually arousing video selected for high arousal content. Alternating blocks of each video type were presented at durations of 30 sec to 2 min per block. In the second, short video clips of 1-2 min duration of relaxation scenes and sports videos occurred before and after a long 9 min sexually arousing video. For both scans, subjects pressed a button to indicate sexual interest, onset of erection, and loss of erection. Penile turgidity data was collected during fMRI using a custom designed pneumatic pressure cuff.

fMRI: All fMRI was performed at 3.0T (GE Signa) using a T2*-weighted GRE spiral sequence (4,5) [TR=3000, TE=30 ms, flip=80°, inplane resolution=3.75 mm, slice thickness=5 mm]. The SPM99 software package (Wellcome Department of Cognitive Neurology) was used for data pre-processing and for generation of functional maps that were superimposed on T2-weighted FSE images. Pre-processing consisted of motion correction (6) and coregistration with the structural scan, spatial stereotaxic normalization using a 9-parameter affine transformation, and spatial smoothing (FWHM = 5mm). Statistical analyses were performed using the general linear model approach (7) in SPM99. Low frequency signal changes that are not significantly correlated with the reference function were modeled as confounding covariates and eliminated. Contrasts between conditions were tested at each voxel with a t-value, with appropriate adjustment in the effective degrees of freedom due to temporal auto-correlations in the fMRI timeseries.

Data Analysis: Two types of analyses were performed: traditional block analyses (N=12), using contrasts between sexually arousing and non-erotic video clips, and a regression analysis using penile turgidity within the scanning session as the covariate of interest (N=10). For each subject, contrast images for both types of analyses were formed, and these images were subjected to a random effects analysis (8) using the general linear model provided by SPM99. Corrections for multiple voxel comparisons were performed using the cluster-size method of (9).

Results

Block Design Analysis (N=12):

Activation clusters did not survive multiple comparison corrections, so an alpha of .001 was used. The only activation for sex vs sports that was significant at $p<.001$ was a small bilateral focus in the lingual gyrus (Brodmann Area 18) and cuneus (BA 31). Weaker activations at $p<.025$ were found in the anterior cingulate region (BA 32/9), right posterior insular region/claustrum, and right inferior frontal gyrus (BA 44).

Penile Regression Analysis (N=10):

Activations were corrected for multiple comparisons at $p<.05$, with a height threshold of $p<.01$. The largest area of activation was bilaterally (right much larger than left) in the insular cortex, claustrum, and lateral basal ganglia (see Figure below of group data).

Smaller significant activations were: bilateral medial occipital gyrus (BA 19), left lingual gyrus (BA 18), right premotor (BA 6), bilateral anterior cingulate (BA 24/32), right hypothal-amus, and right supplementary motor (BA 8).

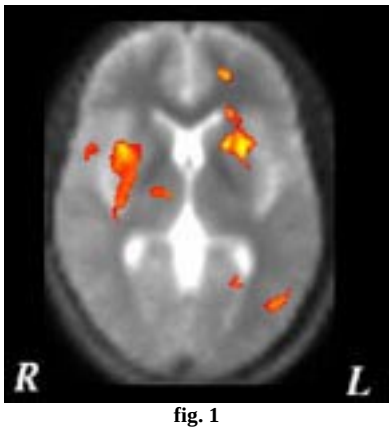

fig. 1

Discussion

Our study demonstrates that objective, quantifiable data can be obtained on male sexual arousal in the fMRI environment. We also show that regional cortical and subcortical activation occurs in healthy heterosexual young males during sexual arousal, which correlates significantly to both subjective arousal and objective penile erection. This study extends previous PET data and provides a basis for comparative studies and therapeutic trials in pathologic states.

References

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