CASE REPORT

THE JOURNAL OF NEUROBEHAVIORAL SCIENCES
NÖRODAVRANIŞ BİLİMLERİ DERGİSİ

Year : 2016
Volume : 3
Issue Number : 2
Doi Number : 10.5455/JNBS.1462260849

Article history:
Received 05 February 2016
Received in revised form 15 February 2016
Accepted 02 May 2016

FUNCTIONAL MRI IN FEIGNED VISUAL LOSS

YAPAY GÖRME KAYBINDA İŞLEVSEL MR GÖRÜNTÜLEME

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Abstract

This single-subject study studied the ability of functional magnetic resonance imaging (fMRI) to discern normal visual condition compared to feigned visual loss and induced-refractive blur condition. Under the normal binocular vision condition, activation of the parieto-occipital area reflected normal patterns of blood oxygenation level-dependent (BOLD) signals in the visual pathway. During the feigned/functional visual loss and refractive-induced blur condition, there was hypoactivation in the parieto-occipital visual pathway. This study showed that the subject could strongly influence the fMRI results, thus, further investigation and protocol refinement are needed to maximize the ability of fMRI to reliably serve as a clinical diagnostic tool in individual functional patients.

Keywords: functional MRI, feigned visual loss, functional visual loss

Özet

Tek denekli bu çalışma, normal görme durumuyla yanıltıcı görme kaybı ve yapay-refraktif bulanıklık durumunu ayırt etmek için fonksiyonel magnetik resonans görünteleme(fMRI) kullanmıştır. Normal binoküler görüş durumunda, parietooksipital alanının aktivasyonu görme yolunda kan oksijenizasyonu bağımlılık düzeyi(BOLD) sinyallerinin normal örneklerini yansıtmıştır. Yanıltıcı/ fonksiyonel görme kaybı ve yapay-refraktif bulanıklık durumu esnasında parietooksipital görme yolunda hipoaktivasyon vardı. Bu çalışma göstermiştir ki; denek, fMRI sonuçlarını ciddi derecede etkileyebilir. Bu nedenle, bireysel fonksiyonel hastalarda güvenilir bir şekilde kliniksel bir teşhis aracı olarak hizmet etmesi için fMRI kullanımının yükseltilmesi amacıyla daha fazla araştırma ve protokol gelişimine ihtiyaç duyulmuştur.

Anahtar Kelimeler: *Fonksiyonel MRI, yanıltıcı görme kaybı, foksiyonel görme kaybı*

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1. Introduction

Functional visual loss refers to asserted decreased acuity, dyschromatopsia, or visual field abnormalities with normal demonstrable visual function. Functional visual loss is present in up to 4% of cases seen in neuro-ophthalmology clinics (Bengtzen et al., 2008).

We studied the ability of functional magnetic resonance imaging (fMRI) to discern normal visual condition compared to feigned visual loss and induced refractive blur condition.

2. Case Report

A healthy 53-year-old male with normal binocular vision underwent fMRI viewing pictures of either objects or scenes (Figure 1a and 1b) under three visual conditions: (1) the normal binocular vision condition with the subject focused on the image, (2) the feigned/functional visual loss condition, wherein the subject intentionally de-focused, but maintained gaze on the image, and (3) the refractive-induced blur condition, wherein the subject attempted to focus on the image while looking through +7.00-diopter lenses.

Figure 1: Examples of object and scene stimuli shown during image acquisition

2.1. fMRI Acquisition Parameters

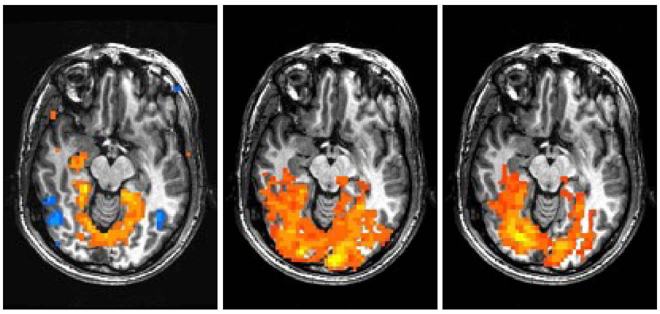
The parameters for the fMRI scan were: gradient-echo EPI, 36 contiguous 3-mm axial slices in an interleaved order, time of echo (TE) = 27.7 ms, time of repetition (TR) = 2500 ms, flip angle = 80°, field of view (FOV) = 22 cm, matrix size = 64 × 64, ramp sampling, and with the first four data points discarded. On each subject condition, each volume of images were acquired 192 times (8 minutes) while a subject was presented with 12 blocks of visual stimulation after an initial 10-second "resting" period. In a predefined randomized order, scenery images were presented in 6 blocks and object images were presented in the other 6 blocks. All pictures were unique. In each block, 10 pictures were presented continuously for 25 seconds (2.5 second for each picture), followed with a 15-second baseline condition (a white screen with a black fixation cross at the center). The subject pressed his right index finger once when the screen was switched from the baseline to picture condition. Stimuli were projected on a back screen in color with a 1024×768 resolution and a visual angle of 23°×30°. After the above functional data acquisition, 180 T1-weighted 1-mm^3 isotropic volumetric inversion recovery fast spoiled gradient-recalled images (10 minute scan time), with cerebrospinal fluid (CSF) suppressed, were obtained to cover the whole brain. These images were used to identify anatomical locations.

2.2 fMRI Data Processing and Analysis

All stimulus fMRI data pre-processing and analysis were conducted with the AFNI software (Cox, 1996) as described in Henderson (Henderson et al., 2011). Essentially, slice-timing correction and rigid-body motion correction were carried. Spatial blurring with a full width half maximum of 4 mm was applied to reduce random noise. Multiple linear regressions (using the "3dDeconvolve" routine in AFNI) were applied on a voxel-wise basis to find the magnitude change when each picture condition was presented, followed with general linear tests, to find the statistical significances between stimulus conditions.

2.3 fMRI Results

Under the normal binocular vision condition, the visual pathway had normal patterns of blood oxygenation level-dependent (BOLD) signals with primary activation of the parieto-occipital area; when viewing scene pictures, additional activation in the parahippocampal regions was present (2a). Figure 2b depicts comparison between normal viewing of scene minus +7.00 lens viewing scene; much less activation is present under the +7.00 lens condition. Figure 2c depicts scene viewing under normal conditions minus scene viewing under feigned defocusing condition and demonstrates less activation with feigned defocusing.



a. b. c.

Figure 2: The parahippocampal place area (in red and yellow) comparing the activation between scene and object pictures under normal viewing condition (a). The activation from viewing scenery pictures was much stronger under normal condition comparing to wearing +7.00 lens (b), and to when purposely feigned defocusing eyes (c).

3. Discussion

fMRI has shown promise in the investigation of patients with functional visual loss. Werring et al. looked at 5 patients with functional vision loss compared to 7 normal subjects (Werring et al., 2004). There was significantly reduced activation of primary visual cortex areas during photic stimulation and greater response in the left inferior frontal cortex, left insula, left corpus striatum, bilateral thalami, limbic structures, midbrain, and left posterior cingulated cortex compared to normals.

JNBS 2016 Published by Üsküdar University www.jnbs.org

Becker et al. imaged a 25-year-old subject during functional bilateral visual loss and upon spontaneous remission of symptoms 5 days later (Becker et al., 2013). During the episode of functional blindness, basic visual cortex responses were unaltered to checkerboard stimulation; however, emotion-specific pictures produced increased activity in the fronto-parietal areas and hypofunction in the occipital cortex. Bobrow et al. looked at 2 subjects with functional tunnel vision and compared them to 1 subject with an organic constricted vision (Bobrow et al., 2010). Blocks of 6-Hz expanding and contracting checkerboard ring stimuli were presented to the subjects. Subjects with functional tunnel vision showed activation to stimuli beyond their apparent field of view and in non-visual cortical areas, while the subject with organic restricted field had limited activation corresponding to their constricted visual fields.

The primary finding in the feigned/functional visual loss arm of this fMRI study is consistent with other functional imaging studies in functional visual loss, revealing hypoactivation of the primary visual regions; however, the frontoparietal and other non-primary cortical activation seen in functional patients with visual, motor, or sensory symptoms (Werring et al, 2004; Becker et al., 2013; Bobrow et al., 2010; Mailis-Gagnon et al., 2013) was not clearly replicated in our study. This perhaps emphasizes the difference between intentional feigned versus functional visual loss. It has been postulated that activation of the frontal and other non-visual areas in functional patients may reflect strategic cognitive function, and perhaps inhibits the normal visual cortical activation (Werring et al., 2004).

3. Conclusion

The subject was able to strongly influence the fMRI results, and accordingly fMRI need further refinement to reliably serve as a clinical diagnostic test in individual functional patients. More precise stimuli-driven areas with specific regional activation, such as the parahippocampal activation when viewing scenery pictures, demonstrate the potential of this technology for use as a valuable individual patient diagnostic test pending further investigation and protocol refinement (Henderson et al., 2011).

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