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Data Article

Hemodynamic response function parameters obtained from resting-state functional MRI data in soldiers with trauma

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ABSTRACT

Functional magnetic resonance imaging (fMRI) is an indirect measure of brain activity, i.e. it is a convolution of the latent (unmeasured) neural signal and the hemodynamic response function (HRF). As such, the HRF has been shown to vary across brain regions and individuals. The shape of the HRF is controlled by both neural and non-neural factors. The shape of the HRF can be characterized by three parameters (response height, time-to-peak and full-width at half-max). The data presented here provides the three HRF parameters at every voxel, obtained from U.S. Army soldiers ($N=87$) diagnosed with posttraumatic stress disorder (PTSD), with comorbid PTSD and mild-traumatic brain injury (mTBI), and matched healthy combat controls. Findings from this data and further interpretations are available in our recent research study (Rangaprakash et al., 2017) [1]. This data is a

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valuable asset in studying the impact of HRF variability on fMRI data analysis, specifically resting state functional connectivity.

Specifications Table

Subject area	*Brain imaging*
More specific subject area	*Functional magnetic resonance imaging, hemodynamic variability, hemodynamic response function parameters, reliability of fMRI, posttraumatic stress disorder*
Type of data	*Image: brain maps of voxel-wise HRF parameters for every subject*
How data was acquired	*Siemens Magnetom Verio 3T MRI Scanner (Siemens Healthcare, Erlangen, Germany)*
Data format	*NifTi (.nii)*
Experimental factors	*Three different populations were considered: those with posttraumatic stress disorder (PTSD), those with comorbid PTSD and post-concussion syndrome (PCS) and healthy combat controls (matched in age, race and education)*
Experimental features	*Resting-state: participants were requested to have their eyes open and fixated on a white cross displayed on a dark background on the display, using an Avotec projection system. They were asked to not think of anything specific. Each resting-state scan lasted for 5 min.*
Data source location	*Auburn, AL, United States of America (GPS coordinates: 32.586, −85.494)*
Data accessibility	*Data is available with this article.*

Value of the data

- This data characterizes the hemodynamic response function (HRF) variability in functional magnetic resonance imaging (fMRI) data obtained from soldiers with posttraumatic stress disorder (PTSD), mild-traumatic brain injury (mTBI) and matched combat controls, and hence is a valuable asset for studying the impact of HRF variability on several types of fMRI data analyses, including resting-state functional connectivity [1].
- The data characterizes HRF variability in different psychiatric populations (PTSD and comorbid PTSD/mTBI) and matched combat controls, and hence could be used to model the common and distinguishing HRF characteristics among these clinical groups [1].
- The HRF is an indirect marker of underlying neurochemical balances since the shape of the HRF is altered by the underlying neurochemistry [2–4]. Hence this data could be used to understand the relationship between HRF and underlying neurochemistry in a healthy population, as well as in psychiatric populations like PTSD and comorbid PTSD and mTBI.

1. Data

The data presented here comprises of the three HRF parameters that characterize the shape of the HRF – response height, time-to-peak and full-width at half-max. Each of these parameters are available at every voxel of the brain for every subject. The data is presented as 3D NifTi images (.nii), with one image file per parameter per subject.

2. Experimental design, materials and methods

2.1. Participants

Active-duty U.S. Army soldiers, aged 18–50 years, were recruited ($N=87$, male) from Fort Benning, GA, USA and Fort Rucker, AL, USA to participate voluntarily in acquiring this data. All soldiers were first assessed by a licensed medical practitioner (i.e. clinician referral) at these locations Symptom severity measures were administered when they arrived for their MRI session. Participants were grouped based on clinician referral, and symptom severity for PTSD (the PTSD Checklist-5 [PCL5] score) and post-concussion syndrome or PCS (the neurobehavioral symptom inventory [NSI] score). PCS is a chronic outcome of mTBI, wherein symptoms persist several months after the concussion. Participants were grouped into PTSD ($N=17$), comorbid PCS and PTSD (PCS+PTSD, $N=42$), and combat controls ($N=28$, groups matched in education, race and age). All participants reported having combat experience in Afghanistan (Operation Enduring Freedom, OEF) and/or Iraq (Operation Iraqi Freedom, OIF). The data acquisition was conducted in accordance with the Declaration of Helsinki (latest version). The procedures and protocol were approved by the Headquarters, U.S. Army Medical Research and Materiel Command (MRMC), IRB (HQ USAMRMC IRB) and Auburn University's Institutional Review Board (AU-IRB).

Participants were grouped based on PTSD symptom severity using the PCL5 score and clinician referral, post-concussive symptoms using the NSI score and medical history (including combat-related mTBI). The PCL5 [5] is a self-report measure that assesses the DSM-V symptoms of PTSD. Items are rated on a 5-point Likert scale, wherein 1 refers to "Not at all" and 5 refers to "Extremely". With an aggregate of 20 items, a total score is obtained in the range 20–100 by summing the scores of each item, with a cut-score of 38 for the diagnosis of PTSD [6]. The NSI [7]) is a self-report questionnaire that assesses post-concussive symptoms in individuals sustaining a traumatic brain injury. For each symptom, participants rate severity (in the past month) on a 5-point Likert scale ranging from 0 (none) to 4 (highly severe). With an aggregate of 22 items, a total score is obtained in the range 0–88 by summing the scores of each item, with a cut-score of 26 for the diagnostic classification of PCS.

(i) Subjects sustaining a history of mTBI, post-concussive symptoms, PCL5 score greater than 38, NSI score greater than 26, no record of a psychotic, mood, or substance dependency disorder, and clinician referral were identified as the comorbid PCS+PTSD group. (ii) Subjects with no history of mTBI in the previous five years, a PCL5 score greater than 38, NSI score less than 26, no record of a psychotic, mood, or substance dependency disorder, and clinician referral were identified as the PTSD group. (iii) Subjects with a PCL5 score less than 38 and NSI score greater than 26, with no record of mild-to-severe TBI, no DSM-5 or DSM-4-TR diagnosis of any psychiatricdisorder (based on medical records) were identified as the combat control group after clinical assessment by a study physician. All participants reported a prior deployment(s) in a combat environment.

2.2. Procedures

When the participants arrived at our research lab, they went through re-screening for eligibility, screening for MR contraindications and re-consenting to ascertain full comprehension of the procedures, benefits and their rights.

fMRI: A Siemens MAGNETOM Verio 3T MRI scanner was used to acquire MRI data (Siemens Healthcare, Erlangen, Germany). Participants were scanned using a T2* weighted multiband echo-planar imaging (EPI) sequence (resting-state: they would have their eyes open, and fixated on a white cross displayed on a dark background on the digital display, using an Avotec projection system; and were asked to not think about anything specific). Acquisition parameters were as follows: TR/TE=600/30 ms, multiband factor=2, FA=55°, voxel size=3×3×4 mm^3 and 1000 time points. Brain coverage excluded the cerebellum. Two separate scans were carried out for every subject (same day), which provided us twice the number of data points compared to the number of subjects. A 32-channel head coil was used to acquire brain imaging data.

2.3. FMRI data pre-processing

Standard fMRI pre-processing steps were undertaken (realignment [six parameters], normalization to MNI space, linear detrending, and regressing out nuisance covariates (six head-motion parameters, cerebrospinal fluid and white matter signals). Spatial smoothing was not performed. Preprocessing was undertaken in Data-Processing Assistant for Resting-State fMRI (DPARSF v1.7) [8], which is based on Resting-State fMRI Data Analysis (REST) Toolkit [9] and Statistical Parametric Mapping (SPM8) [10].

2.4. Obtaining the HRF parameters

The 3D+time fMRI data went through voxel-wise temporal hemodynamic deconvolution to obtain latent neural time series at every voxel. We employed a popular technique proposed by Wu et al. [11]. This technique has received increasing acceptance and popularity, owing to its robustness, interpretability, validity, simplicity of implementation, and an increasing awareness in the research community on the need for deconvolution. Several recent works have employed it (for example, see [12–15]). This deconvolution is blind since we have access to only one variable (fMRI timeseries), using which it estimates both the HRF and the latent neural timeseries. In short, the method models resting state fMRI data as event-related timeseries with randomly occurring events employing point processes [16,17], and then evaluating voxel-wise HRFs using Weiner deconvolution.

Deconvolution resulted in the estimation of HRF at every voxel in every subject, which was characterized by three HRF parameters – response height (RH), time-to-peak (TTP), and full-width at half-max (FWHM). These voxel-wise HRF parameters for all subjects have been made available with this article. All data analysis was performed on the Matlab® platform.

Our main findings associated with this data and further interpretations are part of our recent research study [1].

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Transparency document. Supplementary material

Transparency document data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2017.07.072.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2017.07.072.

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