Reaction Time Variability and Related Brain Activity in Methamphetamine Psychosis

Supplemental Information

Participants

For the methamphetamine (MA) dependent subjects, inclusion criteria were: 1) lifetime diagnosis of MA dependence according to DSM-IV criteria; 2) age range between 18 and 55 years. Controls met the same criteria as the patients, except for the history of methamphetamine dependence. All subjects signed informed consent approved by the University of California, Davis Institutional Review Board and were paid a modest stipend for their participation in the study. Exclusionary criteria for both groups were: 1) substance dependence other than methamphetamine (except nicotine) within the past year; 2) alcohol abuse within the past 5 years; 3) treatment or hospitalization for non-drug related DSM-IV Axis I psychiatric disorders; 4) medical or neurological illness or trauma which would affect the CNS (e.g., stroke or seizure disorder); 5) reported history of a seropositive test for HIV; 6) severe hepatic, endocrine, renal disease, or history of loss of consciousness of over 30 min; 7) compound skull fracture or clear neurological sequelae of head trauma; and 8) metal implantation that would preclude MRI procedure.

Stroop-Paradigm

Three colors were employed in this experiment: red, green and blue. The conflict stimuli (i.e., incongruent [I] trials) were created by printing each of the 3 color names in the two other ink-colors. The non-conflict stimuli (i.e., congruent [C] stimuli) were created by printing each of the three color names in its own color. Each letter within the stimulus words was upper case and subtended 1 degree vertically. Stimuli were back-projected on a screen that could be viewed by the subjects while in the scanner through an MR-compatible angled mirror placed on the head coil. Subjects were instructed to respond to colored words that were either congruent (e.g., the

word Red in red ink) or incongruent (the word Red in blue ink), by depressing a button on a response device that was attached to their dominant hand. Stimuli were presented for 1500 milliseconds (ms) with a fixed inter-trial interval (ITI) of 2500 ms, and both speed and accuracy of responses was emphasized. It is important to note that the use of a constant ITI is important as a jittered ITI may engage additional attentional resources which can interact with the cognitive control processes in a yet not understood way. In order to increase the level of conflict elicited by congruent trials as well as maintain error rates, 70% of trials were non-conflict trials (i.e., congruent) and 30% of the trials were conflict trials (i.e., incongruent). There were on average 198 cC (congruent preceded by congruent) trials; 66 cI (incongruent preceded by congruent) and iC (congruent preceded by incongruent) trials and 42 iI (incongruent preceded by incongruent) trials presented to the subjects. The task included a total of 6 runs of 62 trials each.

Functional Magnetic Resonance Imaging (fMRI) Scan Acquisition

fMRI data were collected on a 3T Siemens TRIO whole-body MRI system (Siemens Medical Solutions, Erlangen, Germany). Three gradient echo structural scouts were used to localize the anterior commissure and the posterior commissure. A T1 spin-echo acquisition was collected for anatomical localization before the functional scanning session. Following the T1 scan acquisition, a T2* weighted, gradient-recalled echo-echo planar imaging sequence was used for functional images (T_E = 40 ms, T_R = 2000 ms, FOV = 220 mm, 64 x 64 matrix). Using these parameters, thirty-six contiguous 3.4 mm slices were obtained in an oblique-axial plane parallel to the anterior commissure – posterior commissure plane. Scanning was fast event-related, with image acquisition synchronized to stimulus onset.

fMRI Preprocessing

Data were preprocessed and analyzed using SPM5 (Wellcome Department of Cognitive Neurology, London). Functional images were corrected for differences in slice acquisition timing, movement corrected, spatially normalized to the Montreal Neurological Institute stereotaxic space and spatially smoothed with an 8-mm full-width at half-maximum isotropic Gaussian kernel.

Statistical Analysis of fMRI Imaging Data

The analyses were performed using a general linear model (GLM) as implemented in SPM5, in two stages. In a first-level analysis, individual subject GLMs were built and fitted to each subject's functional data. The statistical models included regressors coding for onsets of several types of events based on the nature (Congruent, Incongruent, Errors, No-responses) of the current trial and of the immediately preceding trial. Specifically, the model included regressors coding for 7 covariates (cC, iC, iI, cI, Errors, Post-Errors and Non-Responses). Parameter estimates obtained from this first level analysis were used to compute maps of the contrasts of interest for effects of conflict and trial-to-trial effects (I-C for conflict and iI-cI for trial to trial changes in control).