Supplementary Material

Brain Anatomy of Persistent Violent Offenders: More Rather than Less

Jari Tiihonen, Roberta Rossi, Mikko P. Laakso, Sheilagh Hodgins, Cristina Testa, Jorge Perez, Eila Repo-Tiihonen, Olli Vaurio, Hilkka Soininen, Hannu J. Aronen, Mervi Könönen, Paul Thompson, and Giovanni B Frisoni

Psychopathy Ratings

The PCL-R was used to assess psychopathy (Hare et al., 1991). The PCL-R includes 20 items that measure the personality traits and behavior patterns characteristic of psychopathy. Each item is rated on a scale from 0 to 2. 12 of the 26 violent offenders obtained a score of 30 or higher that is required for a diagnosis of psychopathy (Hare et al., 1991). Analyses of PCL-R scores have identified a three factor structure (Cooke and Mitchie, 2001). The factor of Impulsive, Irresponsible Behavioral Style is assessed by five items: need for stimulation; parasitic lifestyle; lack of realistic goals; impulsivity; and irresponsibility. The other two factors are traits of personality. Arrogant Deceitful Interpersonal Conduct is assessed by four items: glibness and superficial charm; grandiose sense of self-worth; pathological lying; and conning/manipulative. Deficient Affective Experience is also assessed by four items: lack of remorse or guilt; shallow affect; callous/lack of empathy; and failure to accept responsibility for own actions (Cooke and Mitchie, 2001).

PCL-R ratings were made by an experienced psychiatrist (E.R.-T.), an authorized PCL-R user, based on extensive case records, that included information from several sources including the offender, family members, friends, teachers, and from complete records of psychiatric care and official criminal files. Family histories were obtained from first degree relatives using a structured questionnaire. This questionnaire also included a section on the development of the offender, behavior up to age 14, home circumstances, discipline, parenting, separations and divorces, education, interests, strengths and weaknesses, and truancy. Information reported by relatives was checked against school records, employment records, and records of compulsory military service. Despite using multiple sources of information, some PCL-R items could not be rated. In the case of

missing values, the sum scores were calculated according to the procedure outlined in the PCL-R manual (Hare et al., 1991). The intraclass correlation coefficients for inter-rater reliability for PCL-R ratings, conducted previously on 98 offenders by E.R-T. (who rated all the cases in the current study) and other authorized raters, were r = 0.94 for the PCL-R total score, r = 0.78 for the personality trait score (Arrogant Deceitful Interpersonal Conduct and Deficient Affective Experience), and r = 0.92 for Impulsive, Irresponsible Behavioral Style. PCL-R ratings were made blind to the MRI data.

The pre-trial psychiatric assessment also included completion of the Wechsler Adult Intelligence Scale (Wechsler, 1981) and the Rorschach (Rorschach, 1921), and undergoing a structural MRI scan.

Magnetic Resonance Imaging

Customized Template. This was obtained by normalizing MR images to the Montreal Neurological Institute (MNI) template (Evans et al., 1993) of SPM2 using a 12-parameter affine transformation, smoothing the normalized images with an 8 mm isotropic Gaussian kernel and averaging the smoothed images. The anterior commissure (AC) was manually set as the origin of the spatial coordinates for the normalization algorithm (Ashburner et al., 1997) by an investigator blinded to the status of participant. The normalization used a trilinear interpolation algorithm to reslice images to voxel size of 2x2x2 mm that was used in the following processing and analysis. All normalized MR images were visually checked with the pertinent routine.

Customized prior probability maps. These were computed by segmenting the normalized images into grey matter (GM), white matter (WM), and cerebrospinal fluid (CSF), then smoothing with an 8 mm Gaussian filter, and finally averaging the segmented images, thus obtaining the customized prior probability maps specific for GM, WM, and CSF (Good et al., 2002).

Main VBM steps. Original MR images were normalized to the whole brain customized template through affine and non-linear transformations with a 25 mm cut-off, medium regularization, 12 iterations, preserving total volumes, and reslicing 2x2x2 mm. The normalized images were segmented into GM, WM, and CSF using the customized prior probability maps, and cleaning the resulting images. The segmented images were smoothed with an 12 mm isotropic Gaussian kernel.

ROI analysis. In order to compute global and lobar GM and WM volumes, a customized program (http://www.jiscmail.ac.uk/cgi-bin/wa.exe?A2=ind02&L=spm&P=R176348&I=-1) was applied to GM and WM images that

are 3D matrices where the intensity of each voxel is proportional to GM and WM volume within each voxel. The program calculates volumes by adding the voxels of the segmented images times voxel volumes. The total intracranial volume (TIV) was computed as the sum of GM, WM, and CSF volumes.

ROI volumes were computed by applying a binary mask to the segmented images. The mask was traced with MRIcro along the boundaries of the four main lobes on the mean of normalized MR images (De Carli et al., 1992, 1994) and volumes were computed as described above and normalized for TIV.

VBM analysis. Smoothed GM and WM images were analyzed with an ANCOVA model ("Single Subjects: conditions & covariates" design in the SPM menu), to detect atrophic and hypertrophic regions of antisocial offenders compared to normal controls. Age and intracranial volume were included as nuisance covariates. P was set at 0.05 corrected. The FDR correction was computed on p values (not on the test statistics). It consists in computing the proportion of false positive tests among the total positive tests according to a complex procedure described in Genovese et al. (2002). Therefore, the amount of voxels surviving the correction depends on the total of activated voxels, and varies at each comparison, independently of the absolute values of the test statistics.

Statistical Analyses

In the analyses, the healthy men were compared to the 26 violent offenders with ASPD and to the sub-group of 12 offenders who fulfilled criteria for a diagnosis of psychopathy. Student's t-test, chi-square test and Fisher exact test were used to compare participants' socio-demographic and clinical characteristics. Analysis of covariance (ANCOVA) was used to evaluate the age-adjusted differences between the violent offenders and healthy men in the lobar volumetry analysis. Effect size (Cohen's'd) was used to describe the robustness of the findings (Cohen, 1988). Within the offender group, univariate analysis of variance (full factorial model) was used to assess the contribution of variables such as PCL-R scores, IQ scores, duration of alcohol abuse, polysubstance abuse and use of current psychotropic medication to regional brain volumes. The association between PCL-R factor scores and regional brain volumes was assessed using Pearson's correlation analysis. In voxel-based morphometry, grey matter and white matter images were analyzed with an ANCOVA model (see MRI method paragraph for details).

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