



XXXII Congresso
Nazionale

Tema congressuale
Relazioni violente
Catanzaro, 18-20 ottobre 2018

RISONANZA MAGNETICA FUNZIONALE E CRIMINOLOGIA

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CR Neuroscienze

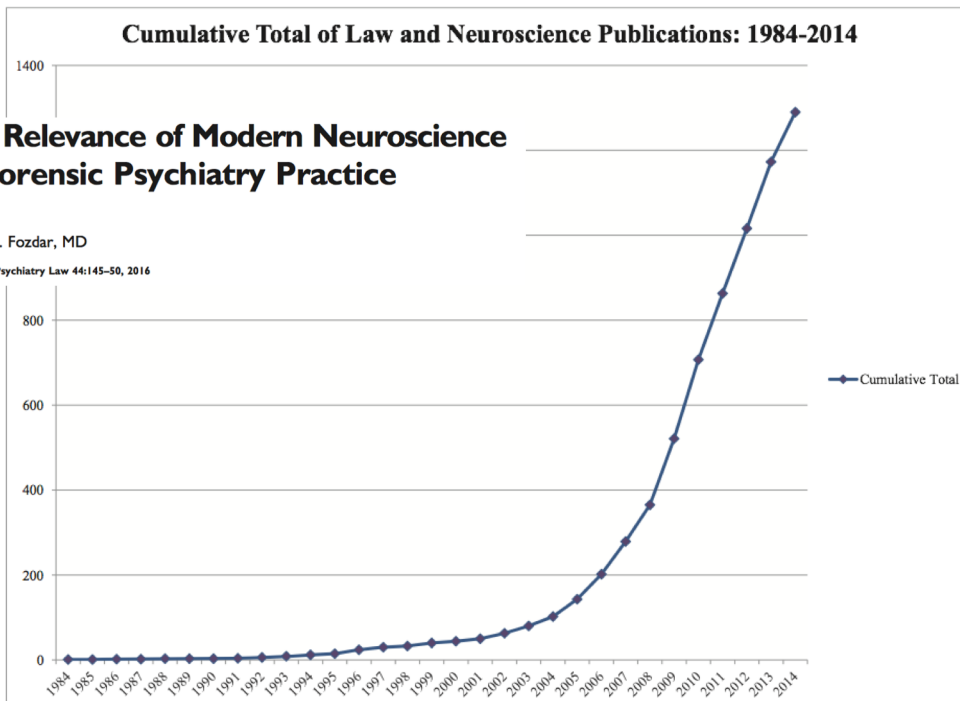
Università degli Studi Magna Graecia di Catanzaro



NEUROIMAGING & CRIMINOLOGY

Modern Neuroscience in the Legal World

Cumulative Total of Law and Neuroscience Publications: 1984-2014



The Relevance of Modern Neuroscience to Forensic Psychiatry Practice

Manish A. Fozdar, MD

J Am Acad Psychiatry Law 44:145-50, 2016

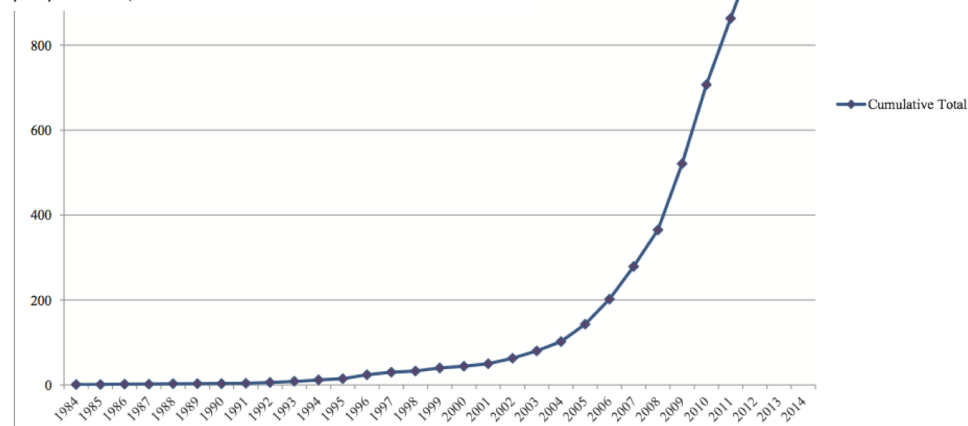


Figure 1. Reproduced with permission from The MacArthur Foundation Research Network on Law and Neuroscience, Law and Neuroscience Bibliography, available at <http://www.lawneuro.org/>.

Neuroimaging, Culture, and Forensic Psychiatry

Neil K. Aggarwal, MD, MBA, MA

The spread of neuroimaging technologies around the world, the emergence of neuroethics and neurolaw. This article discusses the use of forensic neuroimaging within the courtroom. Next, science and technology studies is reviewed to show how tensions about attitudes regarding the self, mental illness, and how forensic psychiatrists can add to this research in medicine. At stake are the fundamental concerns that surround the expectations of medicine.

J Am Acad Psychiatry Law 37:239-44, 2009

Special Issue: Deception Detection: Advances in Forensic Psychology
Original Articles and Reviews

Mind Reading Using Neuroimaging

Is This the Future of Deception Detection?

Matthias Gamer

Departn Francesca Mameli, Cristina Scarpazza, Emanuele Tomasini, Roberta Ferrucci, Fabiana Ruggiero, Giuseppe Sartori and Alberto Priori*

The guilty brain: the utility of neuroimaging and neurostimulation studies in forensic field

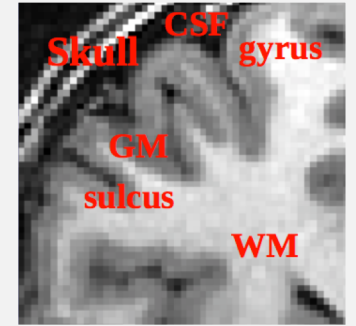
DOI 10.1515/revneuro-2016-0048

Received August 4, 2016; accepted September 17, 2016

- To identify the relationship between the brain and the mind, searching for evidence of how the mind can emerge from its biological substrate.
- Are potentially convicted criminals neurologically predisposed to committing violent crimes?

MRI - STRUCTURAL

Magnetic Resonance Imaging



- Best for visualizing neuroanatomy.
- T_1 -weighted: bone white, white matter light grey, grey matter medium grey, water/CSF/air black.
- Morphometry examines the shape, volume, thickness, area and integrity of structures:
 - Manually segmenting a few regions of interest.
 - *Voxel based morphometry* (VBM), independent statistical comparison for each voxel in the brain.
 - *Freesurfer*, cortical thickness.

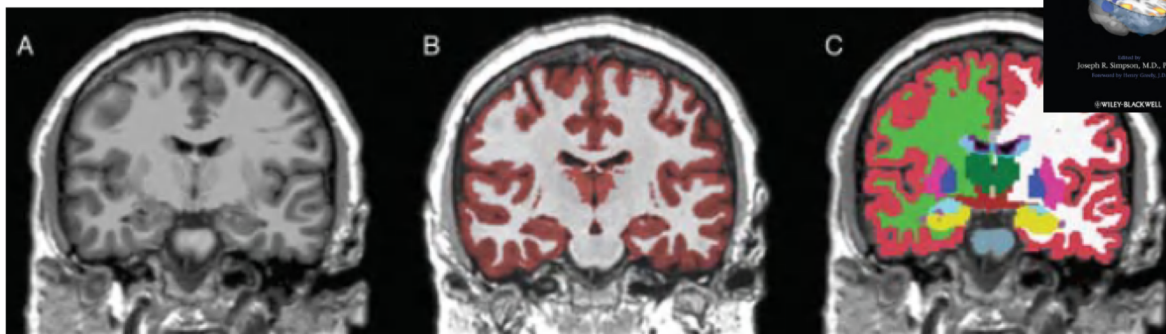
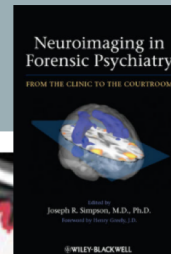
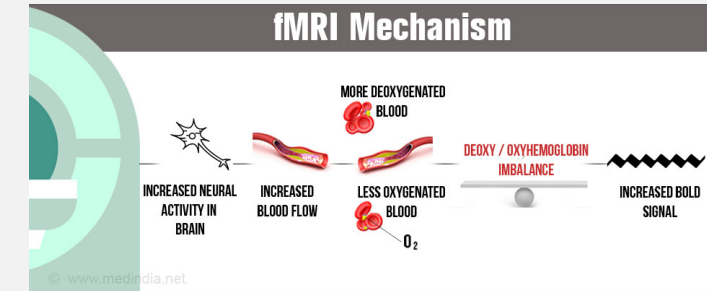


Plate 2 (Figure 2.3) Segmentation and classification. (A) T1 image; (B) segmented image where red reflects gray matter, white is white matter and black represents CSF; (C) classified image where each color designates a different structure or region of interest.

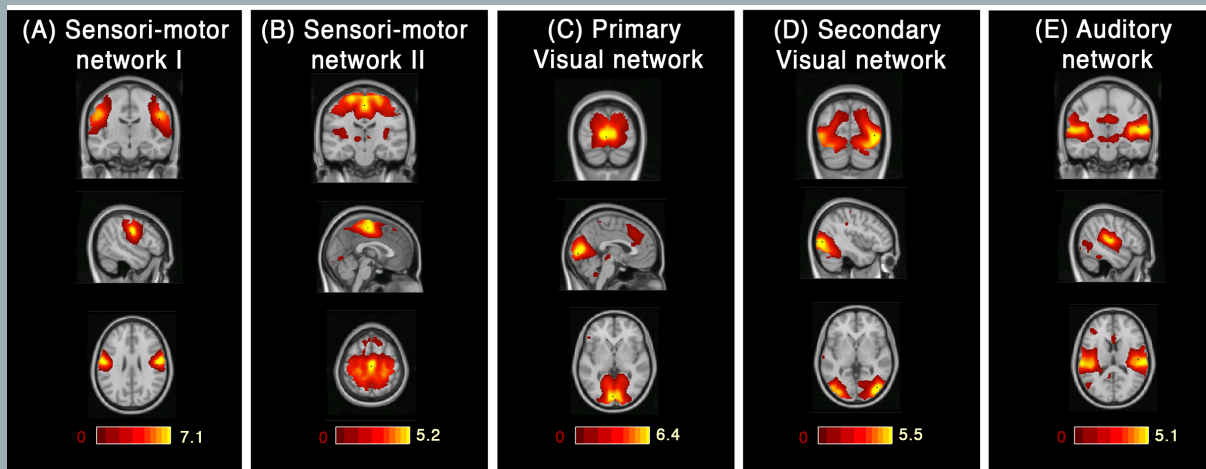


FMRI - FUNCTIONAL

Magnetic Resonance Imaging



- **BOLD** (Blood Oxygen Level Dependent) image intensity based on local balance of oxygenated and deoxygenated hemoglobin.
- **Resting-state** or **Task-based** fMRI.
- Processing techniques:
 - *Seed-based approach*, a priori knowledge/hypothesis;
 - *Independent component analysis (ICA)*, more exploratory;
 - *Graph theory*, exploratory.

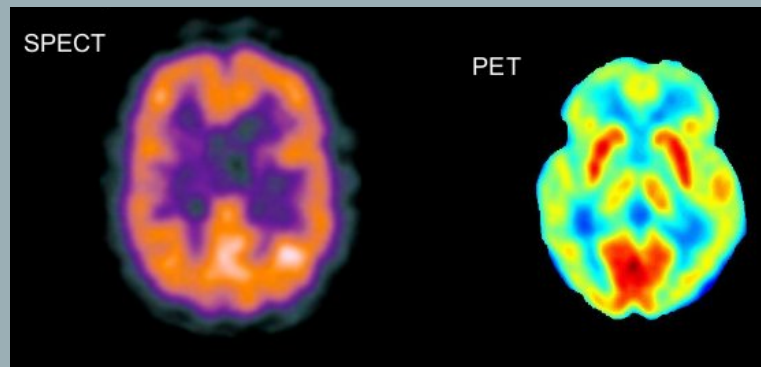


PET & SPECT

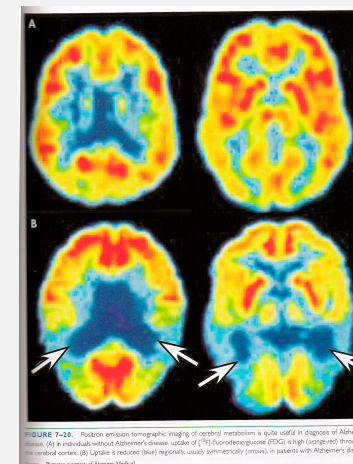
Nuclear Medicine

Positron emission tomography

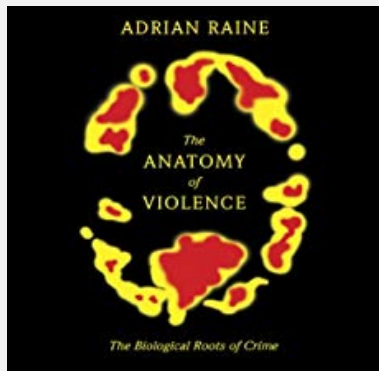
Single-photon emission computed tomography



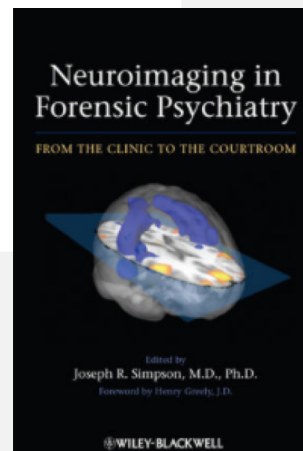
- Measure radioactive decay to create images of tissue function:
 - Unstable nuclides incorporated into desired molecules.
 - Emit photons as they return to more stable state.
 - Captured by detectors, processed by computer, to yield functional image of tissue.
- Blood flow
- Glucose Metabolism



PET of Glucose Metabolism in normal v. Alzheimer's Disease



NEUROIMAGING IN PSYCHOPATHY AND ANTISOCIAL PERSONALITY DISORDER



- Psychopathy-related behavioural disorders consistently correlated with alterations in specific brain areas:
 - **Prefrontal cortex**
 - **Amygdala**
 - **Angular gyrus and posterior cingulate**
 - **Hippocampus**



PREFRONTAL CORTEX ALTERATIONS

- **MRI**
 - 11% volume reduction in ASPD (Raine et al.).
 - Reduced thickness in psychopaths (Yang et al.).
 - 22% volume reduction in unsuccessful psychopaths compared to successful psychopaths and controls (Yang et al.).
- **PET**, reduced functioning (New et al.; Raine et al.; Volkow et al.).
- **SPECT**, reduced blood (Soderstrom et al.; Coccaro et al.).
- **Task fMRI**, reduced functioning during cognitive and emotional tasks, socially interactive game.

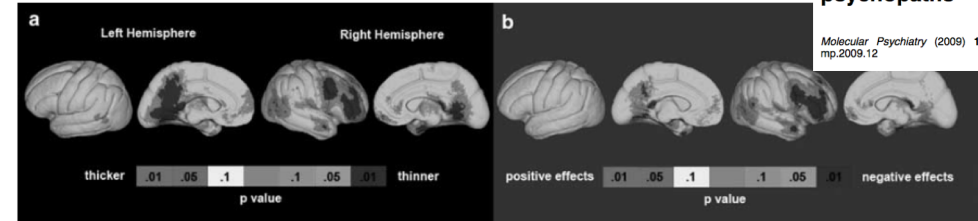


Figure 1 Uncorrected statistical mapping results of the (a) cortical thinning in psychopaths ($N=27$) compared with that in controls ($N=32$) and (b) the correlation between Affective facet and cortical thickness across the entire sample of 59 individuals.

Abnormal temporal and prefrontal cortical gray matter thinning in psychopaths

Molecular Psychiatry (2009) 14, 561–562; doi:10.1038/mp.2009.12

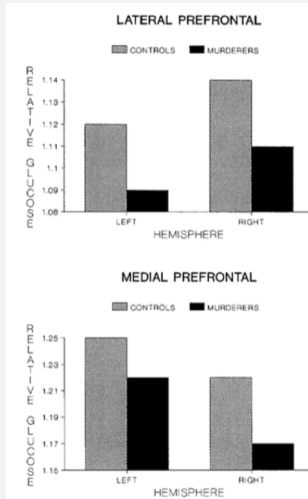


Figure 3 Relative glucose metabolic rates for murders and controls in lateral prefrontal cortex (above) and medial prefrontal cortex (below). Murders have significantly lower lateral ($p < .02$) and medial ($p < .02$) prefrontal functioning in both hemispheres.

Brain Abnormalities in Murderers Indicated by Positron Emission Tomography

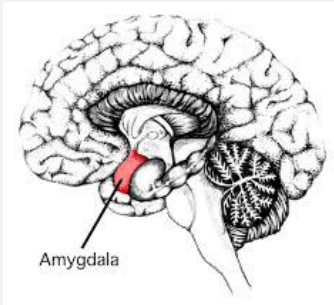
Adrian Raine, Monte Buchsbaum, and Lori LaCasse

HYPOTHESIZED ROLE OF PREFRONTAL REGION

- Abnormality has not been observed in all psychopathic or antisocial individuals:
 - Glucose metabolism of predatory murderers similar to controls, whereas reduced in affective murderers (*Raine et al.*).
 - Psychopathic without prior convictions similar volumes to controls, whereas reduced in with prior convictions (*Yang et al.*).
- **Some psychopathic individuals may exhibit good prefrontal functioning that allows them to carefully plan crimes and avoid being caught.**

- **Altered Executive functions**
- **Altered Processing reward and punishment information**
- **Poor Inhibition of responses**
- **Poor Regulation of emotions**





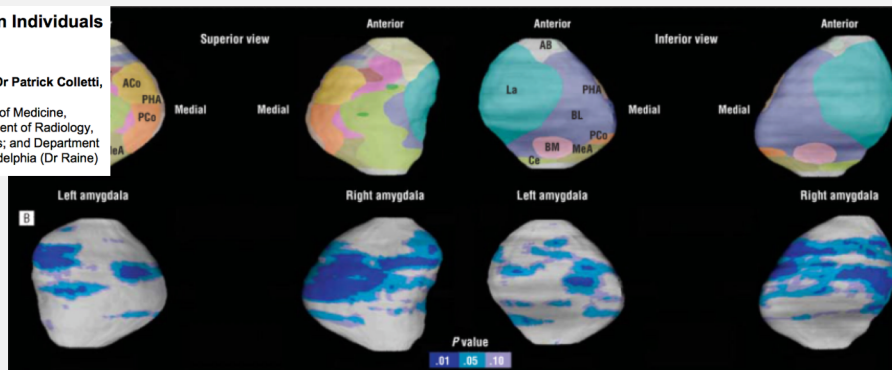
AMYGDALA ALTERATIONS

- **MRI**, reduced volume and deformation in violent offenders and psychopathic individuals (*Yang et al.*).
- **fMRI**, reduced activity during emotional stimuli, fear conditioning, affective recognition task, socially interactive game, moral decision-making about emotional moral dilemmas.
- **fMRI**, increased activation viewing negative visual content and during aversive conditioning.

- No anticipatory fear that normally deters individuals from committing antisocial acts.
- No association harmful actions with the pain and distress of others
- No empathy for victims.

Localization of Deformations Within the Amygdala in Individuals With Psychopathy

Dr Yaling Yang, PhD, Dr Adrian Raine, DPhil, Dr Katherine L. Narr, PhD, Dr Patrick Colletti, MD, and Dr Arthur W. Toga, PhD
Laboratory of Neuro Imaging, Department of Neurology, David Geffen School of Medicine, University of California, Los Angeles (Drs Yang, Narr, and Toga) and Department of Radiology, School of Medicine, University of Southern California (Dr Colletti), Los Angeles; and Department of Criminology, Psychiatry, and Psychology, University of Pennsylvania, Philadelphia (Dr Raine)



NEUROIMAGING IN TRIBUNALE

- Cassazione, sez.V, 27 gennaio 2004 – Cassazione, sez.V, 14 novembre 2006 (Reggiani).
- Tribunale di Como, 20 maggio 2011 (Albertani)
 - **MRI, alterazione volume e densità della materia grigia.**
- Corte d'Assise di Treviso, 20 novembre 2007 (Favaro).
- Corte d'Assise d'Appello di Trieste, 18 settembre 2009 (Bayout):
 - **fMRI, alterazione funzionale frontale rispetto a soggetti sani.**



I LIMITI DEL NEUROIMAGING NELLA GIURISPRUDENZA



LE CAPACITÀ GIURIDICHE ALLA LUCE DELLE NEUROSCIENZE

Memorandum Patavino

9 Ottobre 2015



DIRITTO PENALE CONTEMPORANEO

IL RICONOSCIMENTO DEL RUOLO DELLE NEUROSCIENZE NEL GIUDIZIO DI IMPUTABILITÀ

di Maria Teresa Collica

- ...evidenze ottenute **attraverso analisi di gruppo, non sono automaticamente o necessariamente applicabili a casi individuali.**
- L'inferenza statistica, per essere significativa, si presuppone rasenti la **massima probabilità di esattezza.**
- **Il livello di significatività**, per quanto possa rasentare lo zero per cento di errore, **non lo raggiungerà mai per definizione.**

MACHINE LEARNING & NEUROIMAGING

- A branch of **artificial intelligence**
 - extract information from data and to acquire knowledge.
- Characterisation at individual level, **sensitive to subtle alterations in the brain**, undetectable using traditional univariate methods.
- **BIOMARKER**: *“a characteristic that is objectively measured and evaluated as an indicator of normal biological processes, pathogenic processes, or pharmacologic responses to a therapeutic intervention.”* (1998, National Institutes of Health Biomarkers Definitions Working Group).

Accepted Manuscript

A new MR imaging index for differentiation of progressive supranuclear palsy-parkinsonism from Parkinson's disease

Aldo Quattrone, Maurizio Morelli, Salvatore Nigro, Andrea Quattrone, Basilio Vescio, Gennarina Arabia, Giuseppe Nicoletti, Rita Nisticò, Maria Salsone, Fabiana Novellino, Gaetano Barbagallo, Emilio Le Piane, Pierfrancesco Pugliese, Domenico Bosco, Maria Grazia Vaccaro, Carmelina Chiriaco, Umberto Sabatini, Virginia Vescio, Carlo Stanà, Federico Rocca, Domenico Gullà, Manuela Caracciolo



frontiers
in Neuroscience

ORIGINAL RESEARCH
published: 21 August 2018
doi: 10.3389/fnins.2018.00070

Accepted Manuscript

Title: Editorial on Special Issue: Machine learning on MCI

Author: Alessia Sarica

PII: S0165-0270(18)30082-7
DOI: <https://doi.org/10.1016/j.neumeth.2018.03.011>
Reference: NSM 7966



MRI Asymmetry Index of Hippocampal Subfields Increases Through the Continuum From the Mild Cognitive Impairment to the Alzheimer's Disease

Alessia Sarica¹, Roberta Vasta¹, Fabiana Novellino¹, Maria Grazia Vaccaro¹, Antonio Cerasa^{1,2} and Aldo Quattrone^{1,2} for the Alzheimer's Disease Neuroimaging Initiative¹

science

REVIEW
published: 06 October 2017
doi: 10.3389/fnins.2017.00329

Random Forest Algorithm for the Classification of Neuroimaging Data in Alzheimer's Disease: A Systematic Review

Alessia Sarica¹, Antonio Cerasa¹ and Aldo Quattrone^{1,2}

¹ Institute of Biomaging and Molecular Physiology, National Research Council, Catanzaro, Italy; ² Institute of Neurology, University Magna Graecia, Catanzaro, Italy

Neuroscience and Biobehavioral Reviews 36 (2012) 1140–1152

Contents lists available at SciVerse ScienceDirect

Neuroscience and Biobehavioral Reviews

journal homepage: www.elsevier.com/locate/neubiorev

Review

Using Support Vector Machine to identify imaging biomarkers of neurological and psychiatric disease: A critical review

Graziella Orrù^{a,1}, William Pettersson-Yeo^{a,1}, Andre F. Marquand^b, Giuseppe Sartori^c, Andrea Mechelli^{a,*}



NeuroImage

Volume 145, Part B, 15 January 2017, Pages 265–273

Machine learning of structural magnetic resonance imaging predicts psychopathic traits in adolescent offenders

Vaughn R. Steele^{a, b, c, d, e, f}, Vikram Rao^b, Vince D. Calhoun^{b, d, e, f}, Kent A. Kiehl^{b, c, f, g, h}



CONCLUSIONS

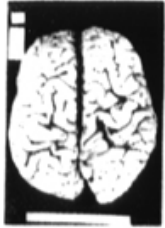
- Neuroimaging in Criminology: MRI, fMRI, PET & SPECT.
- Psychopathy-related behavioural disorders consistently correlated with alterations: prefrontal cortex, amygdala.
- “...non è certo che qualsiasi anomalia cerebrale rilevata possa aver causato l'atto che ha portato una persona ad essere incarcerata piuttosto che essere una conseguenza dell'essere in carcere”
- Le evidenze delle analisi di gruppo non sono automaticamente o necessariamente applicabili a casi individuali.
- Il Machine Learning potrebbe permettere, a scopi di ricerca, la caratterizzazione a livello individuale della psicopatia.
- Dati multi-modali, scanner ibridi PET/MRI, dati cognitivi, psichiatrici, neuropsicologici.

MASSACHUSETTS
DEPARTMENT
OF
MENTAL DISEASES
EXHIBITS
PICTURES OF 50
CRIMINAL BRAINS



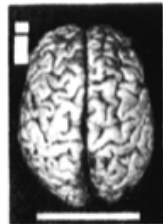
CRIMINAL

576. ALCOHOLIC VAGRANT.
BRAIN NARROW, SIMPLE.
WT. 1550.
MOTHER DIED INSANE.
CANADIAN.

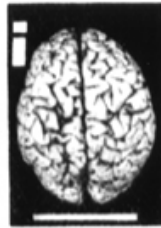


CRIMINAL

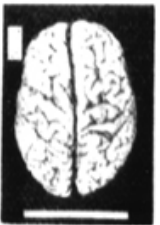
590. SEX PERVERT, VAGRANT.
BRAIN BROAD SHORT ANOMALOUS.
WT. 1400.
GOITER.
PARENTS UNKNOWN.
AMERICAN.



NORMAL



NORMAL



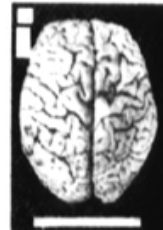
CRIMINAL

954. RAPE.
BRAIN LONG, UNEVEN.
WT. 1230.
PARENTS UNKNOWN.
AMERICAN.



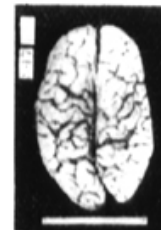
CRIMINAL

585. ALCOHOLIC VAGRANT.
BRAIN LONG, SIMPLE.
WT. 1230.
PARENTS UNKNOWN.
CANADIAN.



CRIMINAL

553. VAGRANT.
BRAIN LONG SQUARE ENDED SIMPLE.
WT. 1370.
PARENTS AND SIBLINGS NORMAL.
IRISH.



CRIMINAL

798. PARETIC VAGRANT.
BRAIN LONG NARROW UNEQUAL.
ATROPHIC, WT. 1200.
PARENTS UNKNOWN.
ITALIAN.

GRAZIE
DELL'ATTENZIONE

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