Can Neuroscience Help Understand Risk For Homicide?

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Burden of Crime in the United States

Incarceration rate in the United States from 1980-2011

- Societal cost of crime estimated to be $3.2 Trillion/yr in the United States (Anderson, 1997; 2011)
- >$10,000 for every man, woman, and child in United States
- 200 new jail/prison cells built every day in the United States
Prediction is Everywhere

- **Intake**: bail, drug court, diversion programs
- **Custody**: sentence length, security level, parole, civil commitment
- **Release**: treatment program assignments, medication, SVP status
Actuarial Prediction
Risk & Protective Factors

• Age
• Genetics
• Age at first offense
• Index offense type
• Mental Illness
• Alcohol/Substance abuse/dependence
• Employment
• Social support
• Psychopathy Checklist-Revised (PCL-R)
• Impulsivity
Inhibitory Function: Go/No Go Task

3 Go stimuli every 6 seconds
80% Go; 20% No Go
No Go stimuli every 10-15 secs

Random ISI of 1, 2, or 3 secs
Offender Sample: Mistakes vs Correct

- N = 96
- Rearrest rate: 53.13%

False Alarm Rate:
- Low ACC = 27%
- High ACC = 23%

- Peak: +3, 24, 33
Cox Survival Analysis

Crimes (Nonviolent) (ACC split)
O.R. = 4.4**

Brain Scans Predict Recidivism

Test controls for:
- Age at release, PCL-R & factors, Alc & Drug problems, Trait anxiety, FA rate.
<table>
<thead>
<tr>
<th>Symptoms of Psychopathy from Hare PCL-R</th>
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<tbody>
<tr>
<td><strong>Interpersonal/Affective</strong> Factor 1</td>
</tr>
<tr>
<td>1) Glib/ superficial</td>
</tr>
<tr>
<td>2) Grandiose</td>
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<tr>
<td>3) Pathological liar</td>
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<td>4) Conning/Manipulative</td>
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<td>5) Lack of Remorse/ Guilt</td>
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<td>6) Shallow affect</td>
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<td>7) Callous/ Lacks empathy</td>
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<td>8) Lack of realistic long term plans</td>
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<td>9) Failure to accept consequences of actions</td>
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<td>10) Irresponsibility</td>
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<tr>
<td><strong>Impulsive/Behavioral</strong> Factor 2</td>
</tr>
<tr>
<td>11) Need for stimulation</td>
</tr>
<tr>
<td>12) Parasitic lifestyle</td>
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<tr>
<td>13) Impulsivity</td>
</tr>
<tr>
<td>14) Sexual promiscuity</td>
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<td>15) Many marital relationships</td>
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<td>16) Poor behavioral controls</td>
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<tr>
<td>17) Early behavioral problems</td>
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<tr>
<td>18) Juvenile Delinquency</td>
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<tr>
<td>19) Recidivist</td>
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<tr>
<td>20) Criminal versatility</td>
</tr>
</tbody>
</table>

(Hare, 1993; 2003)
Psychopathy scores (PCL-R): North American Samples

N = 5408
M = 22.1
SD = 7.9

Average Inmate

U.S. General Population

PCL-R Total Score

(Hare, 1993; 2003)
Psychopathy scores (PCL-R): North American Samples

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Psychopathy scores (PCL-R): North American Samples

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ASU Attendees

Average Inmate

One Attendee

PCL-R Total Score

(Hare, 1993; 2003)
“Why”? Recidivism and Psychopathy

(Hodgins, Cote & Ross, 1992)
Violent Recidivism and Psychopathy

(Rice & Harris, 1997)
Psychopathy and Violent Recidivism in Youth

(Vincent et al., 2003)
Can Neuroscience Inform This Case?
Mind Research Network Mobile Imaging System

1.5T MAGNETOM Avanto
Sample Characteristics (n>3500)

Adults – psychopathy, substance abuse, trauma, decision-making, impulsivity

Youth – development, ADHD, CU/CD Traits, empathy

Forensic Psychiatric – psychosis, depression, impulsivity

Civil Commitment – IQ, paraphilia

Adult Male (n=2500)

Adult Female (n=350)

Youth (n=350)

Civil Commitment (n=300)

Forensic Psychiatric (n=150)
Voxel-Based Morphometry
Pre-processing Overview

Original → Normalization → Segmentation → Modulation → Smoothing

Template → GM prior → WM prior → CSF prior → Gaussian Kernel
What do Neuroscientist’s know about “Gray Matter”

The Bad News: As age goes up, gray matter goes down
What do Neuroscientist’s know about “Gray Matter”

The Good News:
As age goes up, some gray matter goes up too!!!
What do Neuroscientists know about “Gray Matter”?

IQ highly correlated with Gray Matter

Graph showing the correlation between IQ estimate and Middle Frontal Gyrus.
Brain gray matter abnormalities in adult males with psychopathy (n=298; Ermer et al., 2012)
Brain gray matter abnormalities in boys with Callous/Unemotional Traits (n=199; Ermer et al., 2013)
Brain gray matter abnormalities in girls with Callous/Unemotional Traits (n=39; Cope et al., in press)
Summary: Brain Gray Matter \( x \) Psychopathic Traits in Incarcerated Adult Males and Adolescent Males and Females; Sample size \( n > 500 \)

Boys (age 13-18; \( n = 199 \); Ermer et al., 2013)
Jeremy and Jennifer Richman created the foundation following the loss of the 26 child/educators at Sandy Hook elementary school.

Foundation Mission is to raise awareness and funding to study relationship between mental illness and violence with ultimate goal to improve outcomes.
Epidemic of Mass Shootings

- 1/25,000 is the relative risk for homicide in the United States population

- 1/629 presentations of first-episode psychosis will result in a homicide in the next year (Nielssen & Lange, 2010)

- Almost 50% of homicides committed by psychotic patients occur prior to treatment

- With treatment the risk of homicide in patients with psychosis drops to 1/9090 (Nielssen & Lange, 2010).
PSYCHIATRIC DIAGNOSIS

First episode patient

Database of other first episode patients

Bipolar  Schizophrenia  Affective
Brain Scans Discriminate Patients with Schizophrenia/Bipolar from Healthy Controls

Brain Scans Discriminate Patients with Schizophrenia/Bipolar from Healthy Controls

Temporal Lobe and “Default” Hemodynamic Brain Modes Discriminate Between Schizophrenia and Bipolar Disorder

Vince D. Calhoun,1,2,3,4§ Paul K. Maciejewski,2 Godfrey D. Pearlson,1,2 and Kent A. Kiehl1,2,3,5

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2Department of Psychiatry, Yale University School of Medicine, New Haven, Connecticut
3The MIND Institute, Albuquerque, New Mexico
4Department of ECE, University of New Mexico, Albuquerque, New Mexico
5Department of Psychology, University of New Mexico, Albuquerque, New Mexico

 Discriminating schizophrenia and bipolar disorder by fusing fMRI and DTI in a multimodal CCA+ joint ICA model

Jing Su2,§, Godfrey Pearlson1,4, Anvind Caprihan5, Tülay Adali6, Kent A. Kiehl5,§, Jingyu Liu5,§, Jeremy Yamamoto6, Vince D. Calhoun2,3,4,§

Three-way (N-way) fusion of brain imaging data based on mCCA + jICA and its application to discriminating schizophrenia

Jing Su5,§, Hao He6,§, Godfrey D. Pearlson1,4, Tülay Adali5, Kent A. Kiehl5,§, Qingbao Yu6,§, Vince P. Clark5,§, Eduardo Castro5,§, Tonya White5,§, Bryon A. Mueller6,§, Beng C. Ho4, Nancy C. Andreasen1, Vince D. Calhoun2,3,4,§

High classification accuracy for schizophrenia with rest and task fMRI data

Wei Du1,§, Vince D. Calhoun2,3, Hualiang Li1,§, Sai Ma1,§, Tom Eichele4, Kent A. Kiehl5,§, Godfrey D. Pearlson5,§ and Tülay Adali6,§
Is there anything ‘special’ about people who commit homicide?

Youth Incarcerated Sample
Homicide (n=20) vs not (n=135)

VBM results, controlling for brain volume, PCL-YV, substance abuse.
Burden of Crime in Wisconsin

- Wisconsin budget is $1.1 billion for the 180,000 students in the University of Wisconsin system ($6000/per)

- State of Wisconsin spends $1.0 billion on 22,000 inmates; over 45,000 per inmate

- 7.5x the cost per inmate as UW student!
Burden of Crime in Arizona

• State of Arizona budget is $700,000,000 for the 136,000 students at ASU, U of A, & NAU; $5,000 per student

• State of Arizona spends ~$1 billion on 40,000 inmates; over $25,000 per inmate

• 5x the cost per inmate as an Arizona student!
Importance of Early Intervention
Youth Treatment Study (2-year follow-up)

All Serious Offenders: Hare PCL-YV Total > 27

(Caldwell et al., 2006)
Return on $10,000 investment in treatment

### Graph:
- **S&P 500**
- **MJTC**

**Y-axis:** $0 - $80,000
- **Start:** $11,452
- **1 year:** $23,900
- **3 years:** $47,800
- **Life of the study:** $71,800

**X-axis:**
- **Start**
- **1 year**
- **3 years**
- **Life of the study**

**Legend:**
- **Red** (S&P 500)
- **Green** (MJTC)

**Values:**
- **$19,152.00**
- **$71,800.00**
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