Understanding sexual offending and the brain:
Brain basics to state of the art

James M. Cantor, PhD, CPsych
Psychologist & Head, CAMH Law & Mental Health Research Section
Associate Professor, University of Toronto
Editor-in-Chief, Sexual Abuse
http://individual.utoronto.ca/james_cantor

Remember: MRI is painless

Basics
Vocabulary *(for people who don’t tweet, vlog, or sext)*
Brief history: classic, neuropsych., early imaging
Phallometry
Sensitivity/specificity of diagnostic tests
Physics *(for folks over 40)*
CT, PET, MRI vs fMRI
How MRIs are analyzed statistically

The state of the art
MRI results
MRI results…explained?
fMRI results
fMRI results…explained?
Sensitivity/specificity
Issues & implications
Sexual offending and the Brain: History

1886  Founding of modern sexology
1900–2000  Large scale studies of forensic samples
1980–1999  Neuropsych testing, early imaging (CT) studies
1999  First neuroimaging study of sexual arousal
2000–  Large-scale studies of homogeneous samples
2007–2008  High-resolution studies of pedophilia published
2007  First fMRI studies of pedophilia published

Richard von Krafft-Ebing (1840–1902)

*Psychopathia Sexualis* (1886)

Sexual anomalies are a “diseased condition of the central nervous system” (p. 61).
Eight decades of IQ testing

Meta-Analysis of all reports, 1931–2004

- 75 reports with IQ data
- 236 non-overlapping samples
- 25,146 cases (7,045 sexual offenders and 18,101 controls)

---

IQ of adult samples by victims’ age group

---

---

---

---
IQ by Definition of “Child” Victim

---


---

Sexual offending and the Brain: History

1886 Founding of modern sexology
1900–2000 Large scale studies of forensic samples
1980–1999 Neuropsych testing, early imaging (CT) studies
1999 First neuroimaging study of sexual arousal
2007–2008 High-resolution studies of pedophilia published
2007 First fMRI studies of pedophilia published
Frontal Lobe vs. Temporal Lobe Theories

Neuropsychological Batteries

**Halstead-Reitan Battery**
- Yeudall (1977) Rapists
- Yeudall et al. (1979) Heterogeneous
- Langevin et al. (1985) Sadists
- Langevin et al. (1988) Sexual killers, aggressives
- Langevin et al. (1989) Exhibitionists

**Luria-Nebraska Battery**
- Graber et al. (1982) Heterogeneous
- Scott et al. (1984) Offenders vs. children, adults
- Hucker et al. (1986) Pedophiles
- Hucker et al. (1988) Sadists, sexual aggressives
- Langevin et al. (1988) Sexual killers, aggressives
- Galski et al. (1990) Heterogeneous
## Neuropsychological Batteries

<table>
<thead>
<tr>
<th>Battery</th>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halstead-Reitan Battery</td>
<td></td>
</tr>
<tr>
<td>Yeudall (1977)</td>
<td>Rapists</td>
</tr>
<tr>
<td>Yeudall et al. (1979)</td>
<td>Heterogeneous</td>
</tr>
<tr>
<td>Langevin et al. (1985)</td>
<td>Sadists</td>
</tr>
<tr>
<td>Langevin et al. (1988)</td>
<td>Sexual killers, aggressives</td>
</tr>
<tr>
<td>Langevin et al. (1989)</td>
<td>Exhibitionists</td>
</tr>
<tr>
<td></td>
<td>Indications of general impairment.</td>
</tr>
<tr>
<td></td>
<td>No reliable localization.</td>
</tr>
<tr>
<td>Luria-Nebraska Battery</td>
<td></td>
</tr>
<tr>
<td>Graber et al. (1982)</td>
<td>Heterogeneous</td>
</tr>
<tr>
<td>Scott et al. (1984)</td>
<td>Offenders vs. children, adults</td>
</tr>
<tr>
<td>Hucker et al. (1986)</td>
<td>Pedophiles</td>
</tr>
<tr>
<td>Hucker et al. (1988)</td>
<td>Sadists, sexual aggressives</td>
</tr>
<tr>
<td>Langevin et al. (1988)</td>
<td>Sexual killers, aggressives</td>
</tr>
<tr>
<td>Galski et al. (1990)</td>
<td>Heterogeneous</td>
</tr>
</tbody>
</table>

## Individual neuropsychological tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trail-Making</td>
<td></td>
</tr>
<tr>
<td>Bowden (1987)</td>
<td></td>
</tr>
<tr>
<td>Cohen et al. (2002)</td>
<td></td>
</tr>
<tr>
<td>Dolan et al. (2002)</td>
<td></td>
</tr>
<tr>
<td>Knox-Jones (1994)</td>
<td></td>
</tr>
<tr>
<td>Langevin et al. (1989)</td>
<td></td>
</tr>
<tr>
<td>Stone &amp; Thompson (2001)</td>
<td></td>
</tr>
<tr>
<td>Tarter et al. (1983)</td>
<td></td>
</tr>
<tr>
<td>Yeudall et al. (1987)</td>
<td></td>
</tr>
<tr>
<td>Controlled Oral Word Assoc.</td>
<td></td>
</tr>
<tr>
<td>Cohen et al. (2002)</td>
<td></td>
</tr>
<tr>
<td>Dolan et al. (2002)</td>
<td></td>
</tr>
<tr>
<td>Knox-Jones (1994)</td>
<td></td>
</tr>
<tr>
<td>Rubenstein (1992)</td>
<td></td>
</tr>
<tr>
<td>Stone &amp; Thompson (2001)</td>
<td></td>
</tr>
<tr>
<td>Yeudall et al. (1987)</td>
<td></td>
</tr>
<tr>
<td>Wisconsin Card Sort</td>
<td></td>
</tr>
<tr>
<td>Cohen et al. (2002)</td>
<td></td>
</tr>
<tr>
<td>Dolan et al. (2002)</td>
<td></td>
</tr>
<tr>
<td>Miller (1997)</td>
<td></td>
</tr>
<tr>
<td>Rubenstein (1992)</td>
<td></td>
</tr>
<tr>
<td>Stone &amp; Thompson (2001)</td>
<td></td>
</tr>
<tr>
<td>Westergren (2002)</td>
<td></td>
</tr>
<tr>
<td>Yeudall et al. (1987)</td>
<td></td>
</tr>
<tr>
<td>Stroop</td>
<td></td>
</tr>
<tr>
<td>Cohen et al. (2002)</td>
<td></td>
</tr>
<tr>
<td>Dolan et al. (2002)</td>
<td></td>
</tr>
<tr>
<td>Stone &amp; Thompson (2001)</td>
<td></td>
</tr>
<tr>
<td>Williams Verbal Learning Test</td>
<td></td>
</tr>
<tr>
<td>Abracen et al. (1991)</td>
<td></td>
</tr>
<tr>
<td>Baker (1985)</td>
<td></td>
</tr>
<tr>
<td>O’Carroll (1989)</td>
<td></td>
</tr>
<tr>
<td>Yeudall et al. (1986)</td>
<td></td>
</tr>
<tr>
<td>Finger-Tapping</td>
<td></td>
</tr>
<tr>
<td>Knox-Jones (1994)</td>
<td></td>
</tr>
<tr>
<td>Langevin et al. (1989)</td>
<td></td>
</tr>
<tr>
<td>Tarter et al. (1983)</td>
<td></td>
</tr>
<tr>
<td>Yeudall et al. (1986)</td>
<td></td>
</tr>
<tr>
<td>Bender Gestalt Test</td>
<td></td>
</tr>
<tr>
<td>Lewis et al. (1979)</td>
<td></td>
</tr>
<tr>
<td>Yeudall et al. (1986)</td>
<td></td>
</tr>
</tbody>
</table>
Individual neuropsychological tests

Indications of general impairment.
(Methodological confound?)
No reliable localization.

Early brain imaging

CT studies
- Graber et al. (1982) Offenders vs. women, children
- Langevin et al. (1985) Sadists, nonsadistic offenders
- Hucker et al. (1986) Pedophiles
- Hendricks et al. (1988) Offenders vs. children
- Hucker et al. (1988) Sadists, nonsadistic vs. women
- Langevin et al. (1988) Incest offenders
- Langevin et al. (1989) Pedophiles
- Wright et al. (1990) Offenders vs. women, pedophiles, incest offenders, nonsex offenders
Early brain imaging

CT studies

http://knol.google.com/k/brain-ct-mri#

Langevin et al. (1988)
Methological Issues

Very small samples.
Heterogeneous offender types.
Poorly validated (or not-validated) instruments.
Excessive “data-mining.”
Lack of control samples.
Very selective citation of findings.

What do I need to remember?

1886–1999

IQ (global functioning)
LNNB/HRB Consistent but only general indications of poor brain function
Neuropsych testing
CT scans
Pedophilia

Child molester: An adult who engages in sexual behavior physically involving one or more children.

Pedophile: An adult whose primary sexual attraction is towards prepubescent children.

- Not all child molesters are pedophiles.
- Not all pedophiles are child molesters.
- Behavior versus attraction.
- Definitions use primary sexual attraction.

Pedophilia

Child molester: An adult who engages in sexual behavior physically involving one or more children.

Pedophile: An adult whose primary sexual attraction is towards prepubescent children.

- Pedophilia differs from child molestation.
- Pedophilia motivates child molestation.
Pedophilia

Child molester: An adult who engages in sexual behavior physically involving one or more children.

Pedophile: An adult whose primary sexual attraction is towards prepubescent children.

Pedophile: Attraction to pre pubescent children.
Hebephile: Attraction to pubescent children.
Teleiophile: Attraction to adults.
Gerontophile: Attraction to the elderly.

Phallometry

Psychophysiological technique for assessing erotic interests in males.

Examinee’s penile blood volume is monitored while he is presented with a standardized set of laboratory stimuli depicting a variety of potentially erotic activities or objects.

Examinee’s penile blood volume increases are taken as an index of his relative attraction to the different classes of stimuli.
Phallometry

Phallometry
Phallometry
Phallometry
Phallometric Stimuli

Stimulus modality: Audiotaped narratives, slides of nudes

Sample narrative:
“You are watching a late movie on TV with your neighbours’ 12-year-old daughter. You have your arm around her shoulders, and your fingers brush against her chest. You realize that her breasts have begun to develop…”

Phallometric Stimuli

Stimulus categories:
- prepubescent girls
- pubescent girls
- adult women
- prepubescent boys
- pubescent boys
- adult men
- neutral stimuli
Phallometry

Men with >3 female adult victims

Phallometry

Men with >3 female child victims
Phallometry

Men with >3 male child victims

Phallometry

Gay men (no victims)
Phallometry

Kurt Freund
(1914–1996)
Phallometry
Validity of Phallometry


Sensitivity: 61%
Specificity: 96%

Validity of Phallometry

Risk Prediction
Hanson & Bussière (1998)
Meta-analysis of 61 follow-up studies
\[ n = 28,972 \] sexual offenders

Strongest predictors of sex recidivism:

<table>
<thead>
<tr>
<th>Predictor</th>
<th>( r )</th>
</tr>
</thead>
<tbody>
<tr>
<td>phallometric assessment (children)</td>
<td>.32</td>
</tr>
<tr>
<td>MMPI scale 5 (M–F scale)</td>
<td>.27</td>
</tr>
<tr>
<td>severe psychological maladjustment</td>
<td>.25</td>
</tr>
<tr>
<td>prior sex offenses</td>
<td>.19</td>
</tr>
<tr>
<td>failure to complete treatment</td>
<td>.17</td>
</tr>
<tr>
<td>negative relationship with mother</td>
<td>.16</td>
</tr>
<tr>
<td>any personality disorder</td>
<td>.16</td>
</tr>
</tbody>
</table>

Differences Betw. Laboratories

Circumferencial vs. volumetric measures
Visual vs. auditory stimuli
Video clips vs. still pictures
Numbers and duration of pictures shown
One vs. many of each stimulus shown
Validation of interpretation methods
Differences Betw. Laboratories


Needs fixing:
- Very small samples.
- Heterogeneous offender types.
- Poorly validated (or not-validated) instruments.
- Excessive “data-mining.”
- Lack of control samples.
- Very selective citation of findings.

Contemporary neuropsychology and biometrics
Intelligence Quotient (IQ)

Covariates: age, age@ESL

\[ F (2, 293) = 6.77 \]

\[ p = .001 \]


---

Verbal memory by phallometric group

Covariates: age, age @ ESL

\[ F (2, 297) = 5.08 \]

\[ p = .007 \]

---

Visuospatial memory by phallometric group

Covariates: age, age @ ESL

$F (2, 255) = 6.51$
$p = .002$


Accidents causing unconsciousness

Age < 13
$p = .01$

Age ≥ 13
$p = .66$

Handedness in Pedophilia and Hebephilia

Covariates: IQ, parental ed., age, age @ ESL

age: Wald = 14.25, p = .0008
sex: Wald = 0.64, p = .43


Proportions failing or in spl. ed. by birth decade

Proportions failing or in spl. ed. by group

Co-variates:
IQ, parental edu.
age, age @ ESL

Wald = 16.72
p = .001

n = 71
n = 139
n = 377
n = 114


Physical Height

Covariate:
age

F (4, 1220) = 4.11
p = .003

n = 237
n = 662
n = 178
n = 148

Are Brain Differences Observable *Directly*?

Magnetic Resonance Imaging (MRI)

How we are going to attack this. In English.

- Little math or physics, some fancy slides
- Vocabulary that you really can use
- Clearing up some common confusions
Current brain imaging technologies

CT  PET  MRI  fMRI

Also: MEG, SPECT, DTI

Current brain imaging technologies

CT  PET

“Open MRI”

Also: MEG, SPECT, DTI
### Current brain imaging technologies

<table>
<thead>
<tr>
<th>CT</th>
<th>PET</th>
<th>MRI</th>
<th>fMRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain imaging technologies</td>
<td>Functional imaging</td>
<td>Structure and function</td>
<td>Functional imaging</td>
</tr>
<tr>
<td>Low on</td>
<td>Radio-labeling</td>
<td>Magnetism</td>
<td>Magnetism</td>
</tr>
<tr>
<td>exposure</td>
<td>(water)</td>
<td>&amp; (deoxy-hemoglobin)</td>
<td></td>
</tr>
<tr>
<td>low clarity</td>
<td>1 mm</td>
<td>3 mm</td>
<td>2 mm</td>
</tr>
<tr>
<td>Low artifacts</td>
<td>No metal</td>
<td>No metal</td>
<td>No metal</td>
</tr>
</tbody>
</table>

Also: MEG, SPECT, DTI

---

### MRI Physics

**Hydrogen protons**

- Magnet off
- Magnet on (RF transmit)
- Magnet on (RF receive)

[Shuttle website](http://cal.man.ac.uk/student_projects/2000/mmmr7/gw/technique3.htm)
### Structural MRI studies of pedophilia

<table>
<thead>
<tr>
<th>Study</th>
<th>Theory</th>
<th>Prediction</th>
<th>Subjects</th>
<th>VBM Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schiltz et al. (2007)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schiffer et al. (2007)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cantor et al. (2008)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Schiltz et al. (2007)

<table>
<thead>
<tr>
<th>Study</th>
<th>Theory</th>
<th>Prediction</th>
<th>Subjects</th>
<th>VBM Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schiltz et al. (2007)</td>
<td>limbic</td>
<td>“temporal”</td>
<td>15 pedophiles 15 community controls</td>
<td>small volume corrected</td>
</tr>
<tr>
<td>Schiffer et al. (2007)</td>
<td>OCD/impulsivity</td>
<td>frontal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cantor et al. (2008)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Schiltz et al. (2007)

<table>
<thead>
<tr>
<th>Study</th>
<th>Theory</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schiltz et al. (2007)</td>
<td>limbic</td>
<td>“temporal”</td>
</tr>
<tr>
<td>Schiffer et al. (2007)</td>
<td>OCD/ impulsivity</td>
<td>frontal</td>
</tr>
<tr>
<td>Cantor et al. (2008)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Schiffer et al. (2007)

<table>
<thead>
<tr>
<th>Study</th>
<th>Theory</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schiltz et al. (2007)</td>
<td>limbic</td>
<td>“temporal”</td>
</tr>
<tr>
<td>Schiffer et al. (2007)</td>
<td>OCD/ impulsivity</td>
<td>18 pedophiles 24 community controls</td>
</tr>
<tr>
<td>Cantor et al. (2008)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Theory</td>
<td>Prediction</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Schiltz et al. (2007)</td>
<td>limbic</td>
<td>“temporal”</td>
</tr>
<tr>
<td>Schiffer et al. (2007)</td>
<td>OCD/impulsivity</td>
<td>frontal</td>
</tr>
<tr>
<td>Cantor et al. (2008)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Junk data or blind monks?**
## Structural MRI studies of pedophilia

<table>
<thead>
<tr>
<th>Study</th>
<th>Theory</th>
<th>Prediction</th>
<th>Subjects</th>
<th>VBM Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schiltz et al. (2007)</td>
<td>limbic</td>
<td>“temporal”</td>
<td>15 pedophiles 15 community controls</td>
<td>small volume corrected</td>
</tr>
<tr>
<td>Schiffer et al. (2007)</td>
<td>OCD/ impulsivity</td>
<td>frontal</td>
<td>18 pedophiles 24 community controls</td>
<td>small volume corrected</td>
</tr>
<tr>
<td>Cantor et al. (2008)</td>
<td>atheoretical</td>
<td>unbiased</td>
<td>65 pedophiles 62 nonsexual offenders</td>
<td>whole brain volume corrected</td>
</tr>
</tbody>
</table>
### Subjects

**Patients**

$n = 65$ sexology patients  
Recruited from the Kurt Freund Laboratory (CAMH, Toronto)

**Controls**

$n = 62$ nonsexual offenders  
Recruited from federal and provincial parole/probation offices

**Exclusion criteria**

- <18 years age
- >300 lbs weight
- Ever suffered traumatic brain injury
- Ever diagnosed with schizophrenia
- Ever employed grinding metal
- Any other metal object in body, counterindicating MRI

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Patients</th>
<th>Controls</th>
<th>Comparison</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>36.4 (13.5)</td>
<td>36.9 (9.4)</td>
<td>$t_{(125)} = -0.23$</td>
<td>.82</td>
</tr>
<tr>
<td>Full-Scale IQ</td>
<td>96.2 (15.3)</td>
<td>96.3 (11.5)</td>
<td>$t_{(125)} = -0.03$</td>
<td>.98</td>
</tr>
<tr>
<td>Education</td>
<td>12.2 (3.0)</td>
<td>12.1 (2.8)</td>
<td>$t_{(125)} = 0.20$</td>
<td>.84</td>
</tr>
<tr>
<td>CAGE alcohol screen</td>
<td>1.1 (1.4)</td>
<td>2.1 (1.6)</td>
<td>$t_{(125)} = -3.8$</td>
<td>.0003</td>
</tr>
<tr>
<td>% non-right-handed</td>
<td>23.1%</td>
<td>14.5%</td>
<td>$\chi^2_{(1)} = 1.52$</td>
<td>.22</td>
</tr>
</tbody>
</table>
### Procedures

<table>
<thead>
<tr>
<th>Sexological Measures</th>
<th>MRI Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-report, offense history</td>
<td>Automated parcellation</td>
</tr>
<tr>
<td>Phalometry</td>
<td>Voxel-based morphometry (VBM)</td>
</tr>
</tbody>
</table>

### Automated Parcellation

![Standard Reference Brain Image](image.png)
Image Acquisition & Processing

124 images/subject were acquired in the coronal plane using a 3-dimensional, inversion-prepped, radio-frequency fast spoiled-gradient recalled-echo sequence on a 1.5-Telsa MRI system.

- Time to inversion: 300 ms
- Time to repetition: 12 ms
- Time to echo: 5 ms
- Flip angle: 20°
- Field of view: 20 cm
- Matrix resolution: 256 \times 256 pixels

- Correct intensity non-uniformity: Sled & Pike (1998)
- Normalization: MNI-Talairach space
- Resampling: 1.0mm isotropic voxels
- Tissue classification: GM, WM, or CSF
- Non-brain tissue removal: Automated, manual check
Stimulus categories:
prepubescent girls  pubescent girls  adult women
prepubescent boys  pubescent boys  adult men
neutral stimuli

Phallometric Pedophilia Index

Parcellated Volumes with Pedophilia Index

<table>
<thead>
<tr>
<th>Brain Region Families</th>
<th>Multiple Regression</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortical Grey Matter (12 regions)</td>
<td>$R = .260, F (12,95) = 0.58$</td>
<td>.86</td>
</tr>
<tr>
<td>Subcortical Grey Matter (11 regions)</td>
<td>$R = .263, F (11,96) = .65$</td>
<td>.79</td>
</tr>
<tr>
<td>White Matter (11 regions)</td>
<td>$R = .473, F (11,96) = 2.51$</td>
<td>.008</td>
</tr>
<tr>
<td>Cerebrospinal Fluid (5 regions)</td>
<td>$R = .274, F (5,102) = 1.66$</td>
<td>.15</td>
</tr>
</tbody>
</table>
Mean (SD) White Matter Volumes by Group

<table>
<thead>
<tr>
<th>Region</th>
<th>Volume (cc³)</th>
<th>Correlation with Pedophilia Index</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>R. Frontal</td>
<td>89.0 (10.4)</td>
<td>-.16</td>
<td>.10</td>
</tr>
<tr>
<td>L. Frontal</td>
<td>93.8 (10.3)</td>
<td>-.17</td>
<td>.07</td>
</tr>
<tr>
<td>R. Temporal</td>
<td>52.3 (5.6)</td>
<td>-.31</td>
<td>.001</td>
</tr>
<tr>
<td>L. Temporal</td>
<td>50.2 (5.5)</td>
<td>-.25</td>
<td>.008</td>
</tr>
<tr>
<td>R. Parietal</td>
<td>49.2 (6.8)</td>
<td>-.32</td>
<td>.0008</td>
</tr>
<tr>
<td>L. Parietal</td>
<td>46.3 (6.4)</td>
<td>-.33</td>
<td>.0005</td>
</tr>
<tr>
<td>R. Occipital</td>
<td>19.2 (4.0)</td>
<td>-.08</td>
<td>.42</td>
</tr>
<tr>
<td>L. Occipital</td>
<td>15.8 (4.0)</td>
<td>.02</td>
<td>.84</td>
</tr>
<tr>
<td>R. Fornix</td>
<td>0.9 (0.2)</td>
<td>-.06</td>
<td>.56</td>
</tr>
<tr>
<td>L. Fornix</td>
<td>0.9 (0.2)</td>
<td>.04</td>
<td>.72</td>
</tr>
<tr>
<td>Corpus callosum</td>
<td>16.4 (2.8)</td>
<td>-.19</td>
<td>.05</td>
</tr>
</tbody>
</table>

What’s a Voxel?
Voxel-Based Morphometry (VBM)

SPM2
Nonlinear registration: Ashburner & Friston (1999)
Custom templates: All-subject averages
Modulation
Smoothing: 10mm full-width-half-maximum, Gaussian blurring kernel

Voxel-wise analyses (GLMs): Indep t s, correlations

VBM of Pedophilic vs. Nonsexual Offender Men
VBM of Pedophilic vs. Nonsexual Offender Men

VBM of Pedophilic vs. Nonsexual Offender Men
VBM of Pedophilic vs. Nonsexual Offender Men

Superior Occipitofrontal Fasciculus
(right) Arcuate Fasciculus

fMRI Studies of Sexual Arousal

Middle Frontal Gyrus (Ferretti et al., 2005; Garavan et al., 2000; Gizewski et al., 2006; Karama et al., 2002; Montosori et al., 2003; Rauch et al., 2000)

Insula and Opercula (Garavan et al., 2000; Gizewski et al., 2006; Karama et al., 2002; Park et al., 2001; Stoléru et al., 1999)

Sup./Inf. Parietal Lobules (Beauregard et al., 2001; Bocher et al., 2001; Ferretti et al., 2005; Mouras et al., 2003; Stoléru et al., 2003)

Occipital Cortex (Beauregard et al., 2001; Bocher et al., 2001; Ferretti et al., 2005; Garavan et al., 2000; Mouras et al., 2003; Park et al., 2001)
But, what does this *mean*?

1. In healthy men, the cortical grey matter regions identified by fMRI studies may actually operate as a single network that serves to "recognize" stimuli as potentially sexual.

2. In pedophilic men, the white matter tissue is insufficient for that network to function accurately.

3. Because no deficit in grey matter volume was detected, the white matter volume may reflect poor myelination rather than low neuronal population.

---

### Junk data or blind monks?

<table>
<thead>
<tr>
<th>Study</th>
<th>Theory</th>
<th>Prediction</th>
<th>Subjects</th>
<th>VBM Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schiltz et al.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2007)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schiffer et al.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2007)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cantor et al.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2008)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Structural MRI studies of pedophilia

<table>
<thead>
<tr>
<th>Study</th>
<th>Theory</th>
<th>Prediction</th>
<th>Subjects</th>
<th>VBM Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schiltz et al. (2007)</td>
<td>limbic</td>
<td>“temporal”</td>
<td>15 pedophiles, 15 community controls</td>
<td>small volume corrected</td>
</tr>
<tr>
<td>Schiffer et al. (2007)</td>
<td>OCD/impulsivity</td>
<td>frontal</td>
<td>18 pedophiles, 24 community controls</td>
<td>small volume corrected</td>
</tr>
<tr>
<td>Cantor et al. (2008)</td>
<td>atheoretical</td>
<td>unbiased</td>
<td>65 pedophiles, 62 nonsexual offenders</td>
<td>whole brain volume corrected</td>
</tr>
</tbody>
</table>
### Structural MRI studies of pedophilia

<table>
<thead>
<tr>
<th>Study</th>
<th>Theory</th>
<th>Prediction</th>
<th>Subjects</th>
<th>VBM Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schlitz et al. (2007)</td>
<td>limbic</td>
<td>“temporal”</td>
<td>15 pedophiles 15 community controls</td>
<td>small volume corrected</td>
</tr>
<tr>
<td>Schiffer et al. (2007)</td>
<td>OCD/impulsivity</td>
<td>frontal</td>
<td>18 pedophiles 24 community controls</td>
<td>small volume corrected</td>
</tr>
<tr>
<td>Cantor et al. (2008)</td>
<td>atheoretical</td>
<td>unbiased</td>
<td>65 pedophiles 62 nonsexual offenders</td>
<td>whole brain volume corrected</td>
</tr>
</tbody>
</table>

### Junk data or blind monks?

- Pedophilia
- Anti-Sociality
- Prefrontal cortex
- Striatum
- Hypothalamus
- Amygdala
- Orbitofrontal cortex
- Cerebellar vermis
- Corpus callosum
- Hippocampus
- Adverse Childhood Events
- Fronto-occipital fasciculus
- Arcuate fasciculus

---

46
functional MRI (fMRI)

CT  PET  MRI  fMRI

functional MRI (fMRI)

fMRI

function
magnetism
deoxy-hemoglobin

no metal
**functional MRI (fMRI)**

Perform two (or more) tasks including a control task. Use statistics to subtract active tasks from control tasks.

Higher bloodflow = higher activity

Stuart Clare, FMRIB

[Image](http://cal.man.ac.uk/student_projects/2000/mmmr7gjw/technique3.htm)
Subject perform two+ tasks, including a control task. Use “subtractive” statistics to compare activity between tasks.

Two kinds of experiments:
- How does pedophilic processing differ from teleiophilic processing?
- Can fMRI serve the same function as a phallometric test?

<table>
<thead>
<tr>
<th>Study</th>
<th>Anatomy</th>
<th>Subjects</th>
<th>Stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walter et al. (2007)</td>
<td>whole brain</td>
<td>pedophiles (type?), healthy controls</td>
<td>nude adult females (?)</td>
</tr>
<tr>
<td>Schiffer et al.</td>
<td>whole brain</td>
<td>homosexual pedophiles, healthy gay men</td>
<td>nude/dressed boys/men</td>
</tr>
<tr>
<td>(2008a)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schiffer et al.</td>
<td>whole brain</td>
<td>heterosexual pedophiles, healthy gay men</td>
<td>nude/dressed girls/women</td>
</tr>
<tr>
<td>(2008b)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sartorius et al.</td>
<td>amygdala center</td>
<td>homosexual pedophiles, heterosexual controls</td>
<td>boys, girls, men, women in swimsuits/underwear</td>
</tr>
<tr>
<td>(2008)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What does this say about cause/effect?

What does this say about nature/nurture?
What are the ethical issues?

Neuroethics
Bioethics
Neurolaw
Legal neuroscience

Does our ability to detect pedophilia have implications?
What if juries buy it too much?
What if it is used to jail/commit people for their intentions?
Privacy? “mental privacy”
Basic issue: consent to assessment (like polygraph?)
Used as employment criterion?
What if...?

Can we replace this:
…with this?

My fears:
My fears:

MRI always right
MRI always wrong
Society’s needs always comes first
Individual rights always come first
Brain tells us everything
Brain tells us nothing
Public overly trusts science
Public doesn’t trust science
“Experts” with defense bias
“Experts” with prosecution bias
Unvalidated techniques
Unvalidated techniques
### My fears:

<table>
<thead>
<tr>
<th>MRI</th>
<th>always wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual rights</td>
<td>always come first</td>
</tr>
<tr>
<td>Brain tells us</td>
<td>nothing</td>
</tr>
<tr>
<td>Public doesn’t</td>
<td>trust science</td>
</tr>
<tr>
<td>“Experts” with</td>
<td>prosecution bias</td>
</tr>
<tr>
<td>Unvalidated</td>
<td>techniques</td>
</tr>
</tbody>
</table>

---

### The State of the Art

- Research
- Clinical
- Screening
- Evidence
Validity of Phallometry

Sensitivity: 61%
Specificity: 96%

Hypothetical Validity

Sensitivity: 99%
Specificity: 99%
Hypothetical Validity

Sensitivity: 99.999%
Specificity: 99.999%

The State of the Art

Does our ability to detect pedophilia have implications?
What if juries buy it too much?
What if it is used to jail/commit people for their intentions?
Privacy? “mental privacy”
Basic issue: consent to assessment (like polygraph?)
Used as employment criterion?

Research ⇒ Clinical ⇒ Screening ⇒ Evidence

- fMRI of amygdala (67% / 67%)
- Digital exam of prostate (53% / 84%)
- Glucose tolerance (58% / 77%)
- PSA for prostate c. (72% / 93%)
- Volumetric phallometry (61% / 96%)
- "Rapid" H1N1 test (51% / 99%)
- HIV antibody (99+% / 99+%)
The stakeholders

Victim groups
Defense experts
Prosecution experts
Treatment clinics
Politically punitive
Profiteers of hysteria

Acknowledgments

CAMH Law & Mental Health
Howard Barbaree
Robert Dickey
Philip Klassen

CAMH Schizophrenia Program
Bruce Christensen
Robert Zipursky

TGH Dept. of Neuroimaging
David Mikulis
Hien Tran

Ontario Ministry of Corrections
Robert Brown

CAMH Image Processing Lab
Noor Kabani
Kate Hanratty
Blake Richards

Kurt Freund Laboratory
Ray Blanchard
Michael Kuban
Thomas Blak
Sophie LaFaille
Nanci Lipstein

Correctional Service Canada
Elias Constantatos
Robert Small