Cognitive Neuroscience of Craving

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Cognitive Neuroscience of Craving

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What is Craving?

State evoked by **People, Places and Things** associated with drug use
Time Course of Craving

Bonson, et al
Neuropsychopharmacology, 2002
HIGH CRAVER

LOW CRAVER

Neutral

Cocaine

Neutral

Cocaine

Dorsolateral Prefrontal

Medial Temporal

Cerebellum

\( r = 0.66 \)

\( p < 0.02 \)

\( r = 0.66 \)

\( p < 0.02 \)

\( r = 0.66 \)

\( p < 0.02 \)

Grant et al. PNAS, 1996
Activations and Deactivations During Presentation of Cocaine Cues

Bonson, et al
Neuropsychopharmacology, 2002

p<0.005, uncorrected.
Extent = 10 pixels. N = 11
Overlap of Activations and Correlations with Craving

Bonson, et al
Neuropsychopharmacology, 2002

Activation

Correlation

$r > 0.7$

$p < 0.005$, uncorrected.
Extent = 10 pixels. $N = 11$
Positive Correlation with Craving in Left Amygdala/Perirhinal Cortex

Bonson, et al
Neuropsychopharmacology, 2002

p<0.005, uncorrected.
Extent = 10 pixels. N = 11
What Does Craving Do?
Craving Captures Attention

Cues + Continuous Performance Task
N= 12 Cocaine Abusers  N= 10 Controls

Group X Session X Time  p < 0.03
Cocaine Craving:
Population (Cocaine Users, Controls) x Film (cocaine, erotic)

Garavan et al A. J. Psych 2000
Craving Influences Decision-Making

- Drug Abusers show abnormal brain activity in Ventral Prefrontal Cortex
- Craving alters brain activity in Ventral Prefrontal Cortex
- Lesions of Ventral Prefrontal Cortex lead to impaired judgment of future consequences.
- Continued drug use despite adverse consequences (DSM IV) is hallmark of addiction.
GAMBLING TASK

"Bad" Decks

A
Payoff /Card $100
Loss /10 Cards $1250
Profit/10 Cards -$250

B
Payoff /Card $100
Loss /10 Cards $1250
Profit/10 Cards -$250

"Good" Decks

C
Payoff /Card $50
Loss /10 Cards $250
Profit/10 Cards $250

D
Payoff /Card $50
Loss /10 Cards $250
Profit/10 Cards $250

NET SCORE = (C+D) - (A+B)
DRUG ABUSERS SHOW MARKED IMPAIRMENT ON GAMBLING TASK

Control Subject Performance (N = 88) from Iowa (A. Bechara, Personal Communication)

Net Score

p < 0.05

Drug Abusers
N = 30

Drug Naive
N = 24

Performance (N = 88) from Iowa (A. Bechara, Personal Communication)
SUBSTANCE ABUSERS SHOW NO IMPAIRMENT ON WCST

Categories Competed (n.s.)

Drug Abusers N = 30
Drug Naive N=24

Perseverative Errors (n.s.)

Drug Abusers N = 30
Drug Naive N=24
IMAGING HYPOTHESES

• Is VmPFC activated during performance of Gambling Task?

• Is VmPFC activation correlated with performance of Gambling Task?

• What other areas are activated during performance of Gambling Task?
GAMBLING TASK PERFORMANCE
300 Cards

Weighted Net Score
(50:28:22)

Controls > Drug Abusers p < 0.001
CORTICAL ACTIVATION DURING GAMBLING TASK

p<0.001, Extent = 10 pixels, uncorrected (11 Abusers + 11 Controls)
PET Activation vs VentroMedial PreFrontal Lesions

Bechara, et al., 1999

$p<0.005$, Extent = 20 pixels, uncorrected (11 Abusers + 11 Controls)
SUB-CORTICAL ACTIVATION DURING GAMBLING TASK

Extended Amygdala?

p<0.001, Extent = 10 pixels, uncorrected (11 Abusers + 11 Controls)
Cortical Activations During Gambling
Task: Controls vs. Drug Abusers

Controls (11)
Abusers (11)
Overlap

$p<0.005$, uncorrected
Extent = 10 pixels
GROUP INTERACTION DURING GAMBLING TASK
Controls > Abusers

p<0.005, Extent = 10 pixels, uncorrected (11 Controls - 11 Abusers)
GROUP INTERACTION DURING GAMBLING TASK

Abusers > Controls

p<0.005, Extent = 10 pixels, uncorrected  (11 Abusers - 11 Controls)
POSITIVE CORRELATIONS WITH GAMBLING TASK
Controls  $r > 0.73$

$p < 0.005$, Extent = 20 pixels, uncorrected  (11 Controls)
NEGATIVE CORRELATIONS WITH GAMBLING TASK

Abusers $r < -0.73$

$p < 0.005$, Extent = 20 pixels, uncorrected (11 Controls)
Drug Abusers Use Different Brain Networks During Gambling Task

<table>
<thead>
<tr>
<th>Controls</th>
<th>Abusers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activations</strong></td>
<td><strong>Activations</strong></td>
</tr>
<tr>
<td>• L. Insula</td>
<td>• R. Superior Parietal</td>
</tr>
<tr>
<td><strong>Correlations (+)</strong></td>
<td><strong>Correlations (-)</strong></td>
</tr>
<tr>
<td>• R. Insula</td>
<td>• L. Basal Forebrain/ Nucleus Accumbens</td>
</tr>
<tr>
<td>• R. Superior Frontal Cortex</td>
<td>• R. Inf. Temporal Pole</td>
</tr>
<tr>
<td>• R. Hippocampus/ Parahippocampus</td>
<td>• Visual Cortex</td>
</tr>
<tr>
<td>• R. Superior Parietal Cortex</td>
<td>• R. Inferior Temporal Cortex</td>
</tr>
<tr>
<td>• R. Inferior Temporal Cortex</td>
<td>• L. Cunneus</td>
</tr>
</tbody>
</table>
What Does Craving Do?

Dysregulation of Cognition
• Evokes Memory
• Captures Attention
• Biases Decision-Making