The Neuroscience of Gambling Addiction

Dr Luke Clark
22nd October 2014
Victorian Responsible Gambling Foundation
Disclosure

The Centre for Gambling Research at UBC is supported by the British Columbia Lottery Corporation and the Province of BC.
PG as the first behavioural addiction

Reclassified from Impulse Control Disorders to Addictions in DSM5 (and renamed ‘Gambling Disorder’)

• Symptom hallmarks
• Co-morbidities
• Shared heritability / genetics
• Effective treatments
• Neuroimaging / neurocognitive similarities

- Escalating wagers (tolerance)
- Withdrawal symptoms
- Repeated attempts to quit
- Pre-occupation
- Gambling to escape
- Loss chasing
- Lying about gambling
- Lose relationship / job
- Borrowing money
Disease model of problem gambling

Korn & Shaffer 1999
Dow-Schull (2012)
Overview

• Similarities and differences in the neurobiological signature of pathological gambling and substance addictions
  – Role of dopamine (PET imaging)
  – Functional MRI of reward processing

• Measurement of gambling-related decision making
  – Cognitive distortions
  – Translational models
Dopamine and Addiction

**FOOD**

![Graph showing % of Basal Release over time for Food](image)

**AMPHETAMINE**

![Graph showing % of Basal Release over time for Amphetamine](image)

Volkow et al

**CENTRE for GAMBLING RESEARCH at UBC**
Dopamine D2 Receptor Binding in PG

Clark et al (2012 NeuroImage)
Increased Dopamine Release in PG

Boileau et al (2014 Mol Psychiatry)

Cf. Substance addictions: reduced dopamine release
Gambling in Parkinson’s Disease

- Corroborate data in primary PG (Steeves et al 09)
- Time locking of DA receptor stimulation to PG
- Related to other ICDs (hypersexuality, shopping)
Functional imaging of gambling tasks

Reuter et al (2005)

CENTRE for GAMBLING RESEARCH at UBC
van Holst et al (2012): during *anticipation* of reward, PG show *increased* activity in ventral striatum (and correlated with SOGS)

Sescousse et al (2013): comparing monetary vs erotic rewards, PG show reduced response to *non-gambling rewards* (→ imbalance)
Cognitive Approach to Gambling

• Gamblers experience distorted processing of chance and skill, causing an over-estimation of chances of winning

• Key examples
  – Gambler’s Fallacy
  – Illusion of Control

• Elevated in problem gamblers and a target for cognitive therapy (Ladouceur)

• Early studies measured with ‘think aloud’ technique and questionnaires (GBQ, GRCS)
Near-Misses

“A special kind of failure to reach a goal, one that comes close to being successful” (Reid 1986)
Near Misses are Aversive but Enhance Motivation to Play

Clark et al (2009 Neuron)
Skin Conductance Responses to Near-Misses

Clark et al (2012 JoGS)
Brain Responses (fMRI)

SLOT MACHINE WINS

-16 -8 4 0 8

Midbrain Insula Striatum mPFC

p<.05 FWE

SLOT MACHINE NEAR-MISSES

-16 -8 4 0 8

p<.001 uncorr

Clark et al (2009 Neuron)
Gambling Involvement and Near-Misses

Clark et al (2009): Insula response to near misses and trait gambling cognitions

Chase & Clark (2010): in regular players, midbrain response to near misses predicts PG symptoms
Gambling distortions following brain injury

Injury to ventromedial PFC n=17
Insula n=8
Amygdala n=7
Healthy controls n=16

Clark et al (2014 PNAS)
Effects of Near Misses

- Most participants report increased motivation to play after *near-miss* outcomes compared to *full-misses*
- Effect abolished in insula group
The Gambler’s Fallacy

- Most participants are less likely to choose RED after a run of consecutive REDs
- Effect abolished in group with insula damage
Role of the Insula? - Interoception

- Key reception zone for bodily input and arousal
- Gambling associated with increased physiological arousal (HR, cortisol)
- Skin conductance responses to wins and near-misses
- Insula overactivity in pathological gambling? Target for bodily treatments (e.g. mindfulness / biofeedback)
Gambling rats?

Rodent slot machine (Winstanley et al, UBC)
A translational model: dopamine data

- Rats respond to near-miss outcomes
- Dopamine drugs modulate these responses (Winstanley et al 2011)
- Preliminary evidence for D4 receptors (Cocker et al 2013)
Conclusions

• PET and fMRI highlight similarities – but also some emerging differences – between problem gambling and substance use disorders

• Neurosciences provide new tools for studying thinking and behaviour during gambling

• Animal models of gambling decisions provide neurobiological precision that is not possible in humans

• Relevance for treatment, disease classification and public awareness
Acknowledgements

Laboratory for Affect, Risk and Gambling Experiments (LARGE)
Bettina Studer (now UCL)
Mike Aitken
Rosanna Michalczuk
Roseline Porchet
Steve Sharman
Eve Limbrick Oldfield
Rachel Cocks
Yin Wu
Sophie Miller

Antoine Bechara (USC)
Joel Bruss (Iowa)
Dan Tranel (Iowa)

Imperial College, London
Henrietta Bowden-Jones
Paul Stokes
Anne Lingford-Hughes
Liese Mick
CENTRE for GAMBLING RESEARCH at UBC

www.cgr.psych.ubc.ca
Twitter @CGR_UBC @LukeClark01
Email luke.clark@psych.ubc.ca