Why gamblers fail to win: evidence from neuroscience

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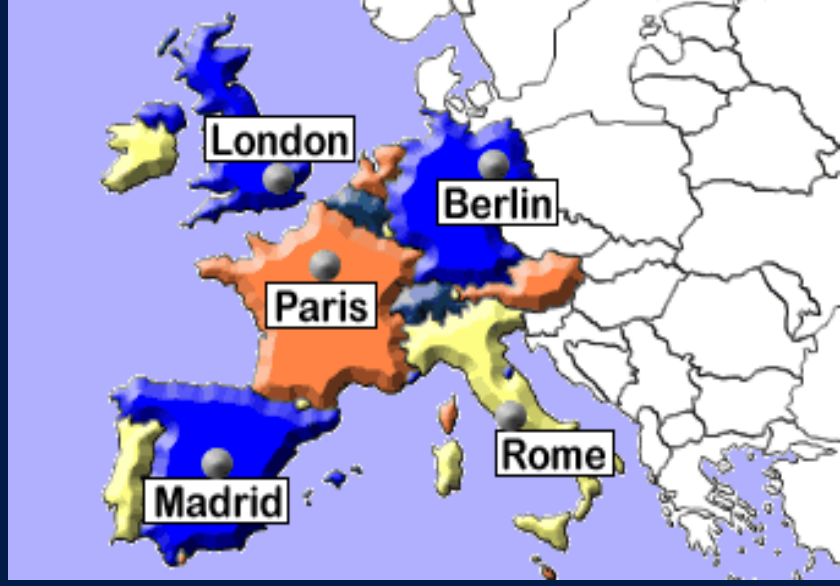
Jellinek

THE AMSTERDAM INSTITUTE FOR ADDICTION RESEARCH

- Gambling in the Netherlands
- Gambling addiction?
- Neuroscience: New neuroimaging research in problem gamblers

Gambling in the Netherlands



17 million inhabitants

Lifetime prevalence of pathological gambling: 0.4-1.2

Annual turnover of gambling revenues:

- 2 billion US Dollars
- 120 million US Dollars state tax income

Source: LADIS 2001,Dutch Ministry of Finance,IVV

Casino's and gambling arcades

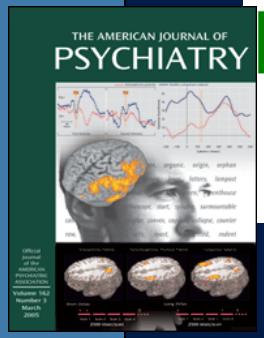
14 Holland Casino's: State is stakeholder

300 gambling halls: 35.000 slot machines

Slot machines in liquor-licensed bars and restaurants legal: 10.000 slot machines

Source: Holland Casino, Slot machine Organisation Netherlands (VAN)

Gambling: a real addiction?



Editorial

Pathological Gambling: Focusing on the Addiction, Not the Activity

CAROL A. TAMMINGA, M.D.
ERIC J. NESTLER, M.D., PH.D.

2006

RESEARCH REPORT

Should the scope of addictive behaviors be broadened to include pathological gambli--?

Nancy M. Petry
University of Connecticut Health Center, Farmington, CT, USA

2006

RESEARCH REPORT

Should addictive disorders include non-substance-related conditions?

Marc N. Potenza
Yale University School of Medicine, New Haven, CT, USA

Gambling and Substance Use Disorders: Current Status and Future Directions

Nancy M. Petry, PhD
University of Connecticut Health Center, Farmington, Connecticut

2007

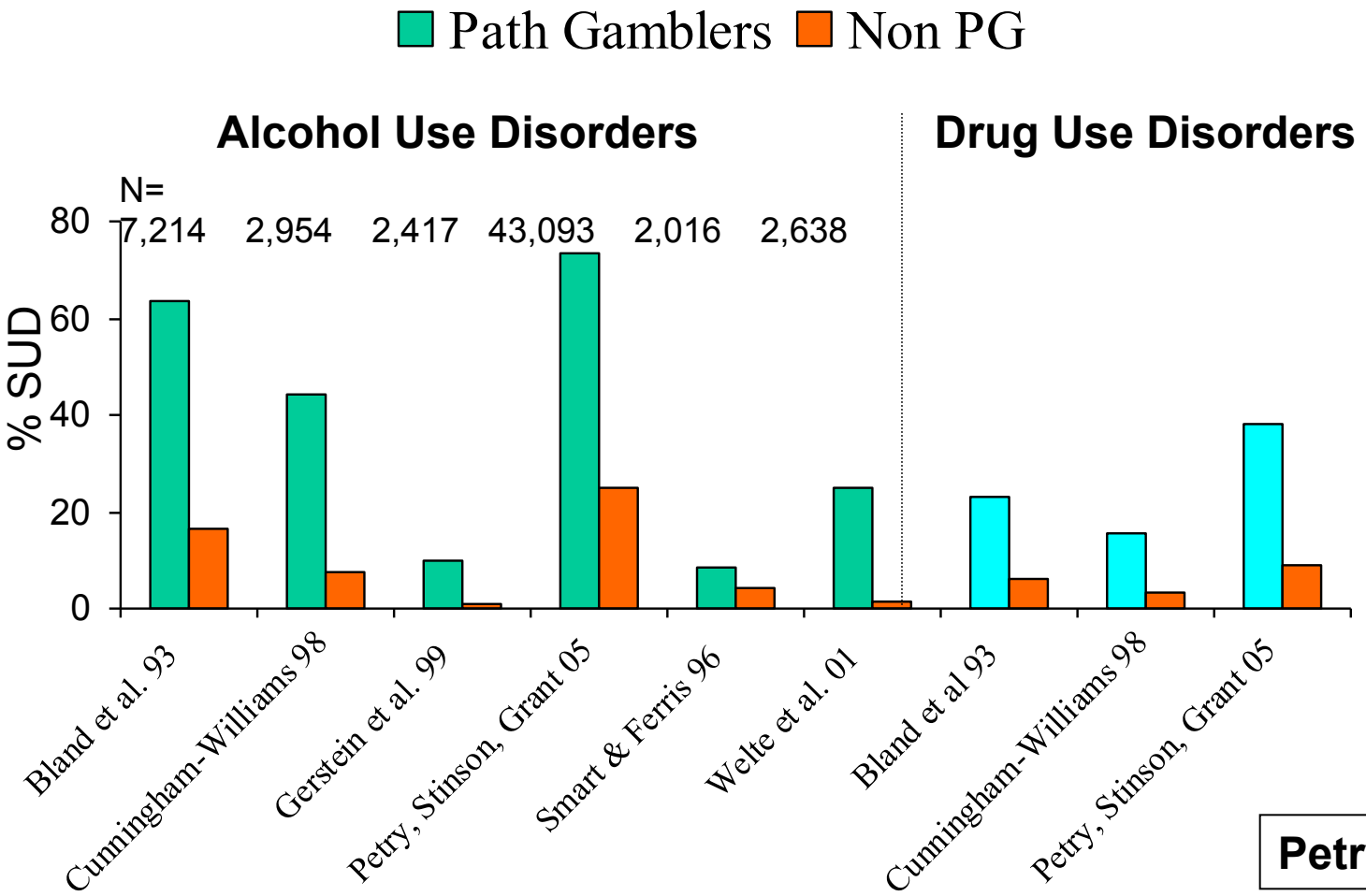
Pathological gambling: a disorder of self-regulation

DSM-IV: persistent and recurrent maladaptive gambling behavior

- preoccupation with gambling
- gambling with increasing amounts -> achieve desired excitement
- unsuccessful efforts to control or stop gambling
- restless or irritated when trying to stop
- financial and social problems due to gambling

- **Returning after losing to try to win back money that was lost**

Comorbidity PG-SUD: general population



Petry, 2007

Pathological Gambling as a behavioral addiction

DSM-5 to reclassify PG with 'Addiction and Related Disorders' based on similarities:

- Core symptoms (criteria)
- Co-morbidities
- Shared heritability / genetics
- functional imaging and neurocognitive profile
- Effective treatments (CBT, nalmefene)

What's the fun in gambling?

- Winning?
- Excitement?
- Prospect of a different life?
- Stress release?
- Rewarding effect when gambling?

- What's different in problem gambling?

Pathological Gambling as a behavioral addiction

DSM-5 to reclassify PG with 'Addiction and Related Disorders' based on similarities:

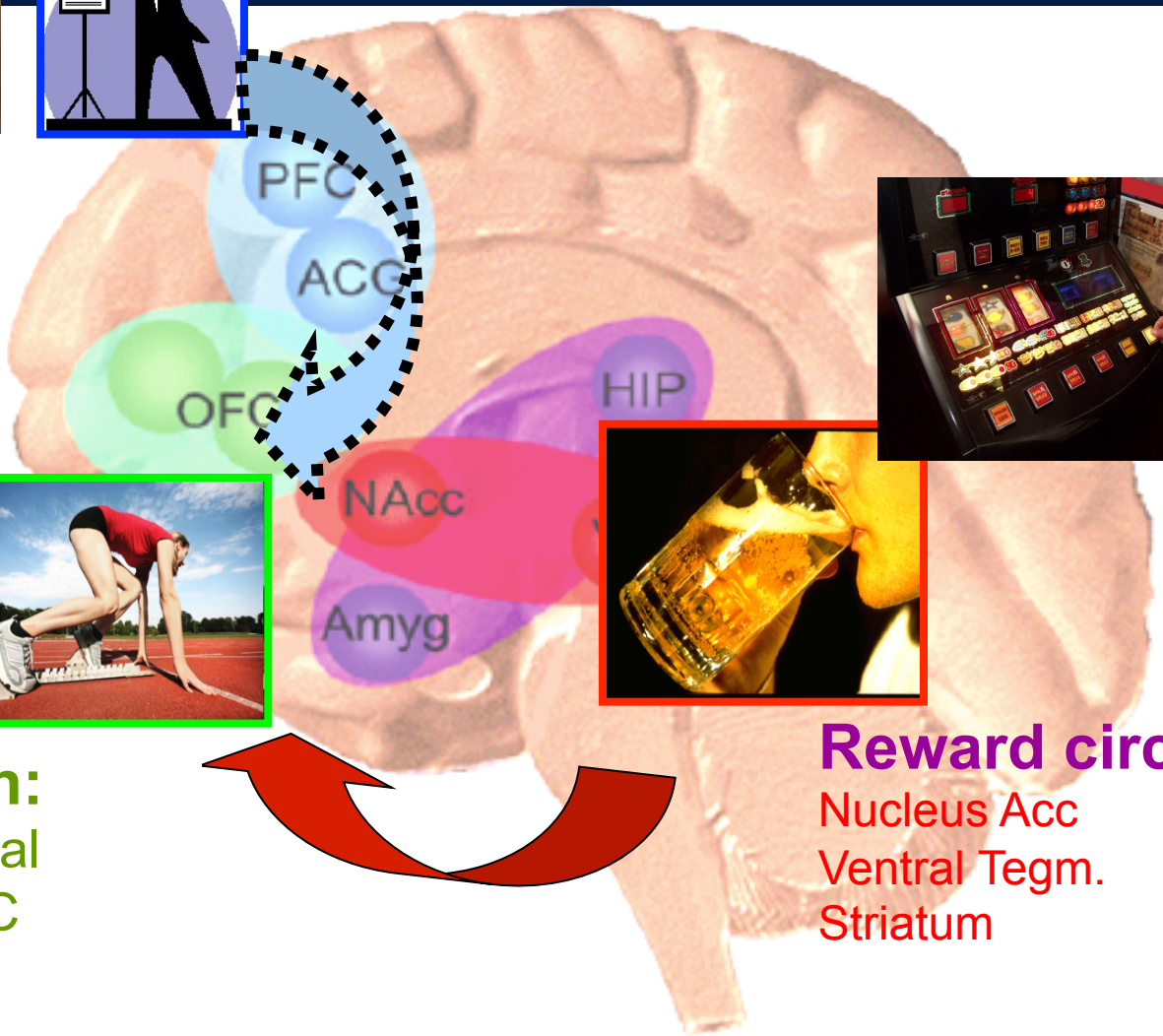
- Core symptoms
- Co-morbidities
- Shared heritability / genetics
- **functional imaging and neurocognitive profile**
- Effective treatments (CBT, nalmefene)

Similar brain processes in (pathological) gambling as in substance dependence?

- Reward circuitry activated when winning money, and when anticipating winning money

Impaired Response Inhibition-Salience Attribution model

(Goldstein & Volkow, 2002, 2006)



Control:
Dorsolateral Prefrontal Cortex
DLPFC / ACC

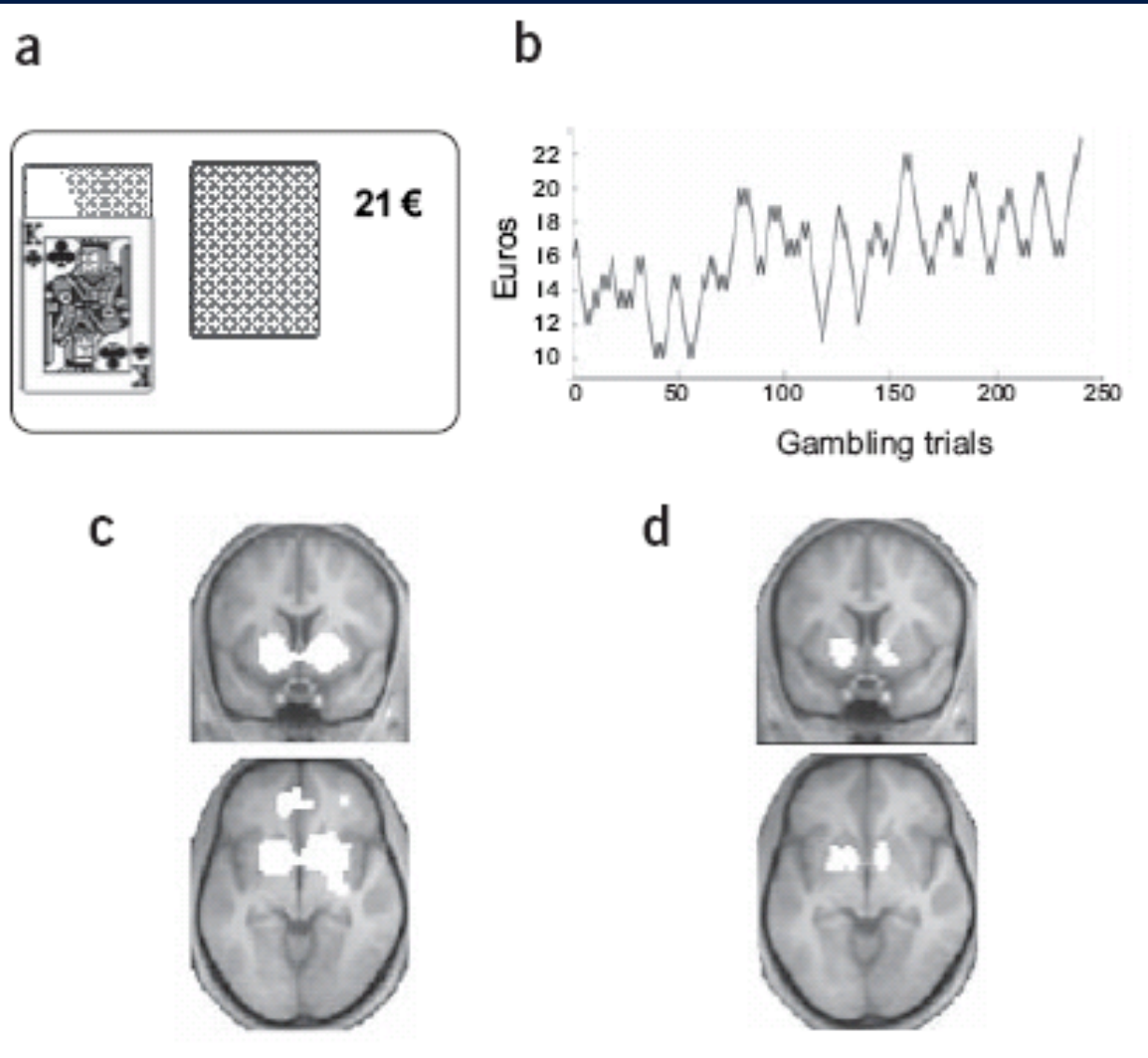
Motivation:
Orbital Frontal Cortex - OFC

Reward circuitry:
Nucleus Acc
Ventral Tegm.
Striatum

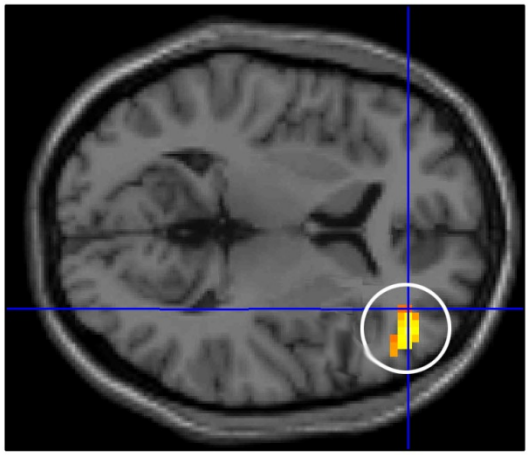
Brain activity after winning money in (problem) gamblers

Reuter et al. (2005, *Nat Neurosc*):

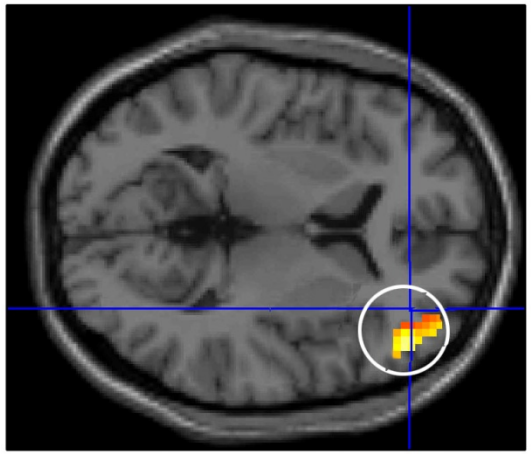
- Diminished activity of reward related brain areas
- Ventral striatun
- VMPFC



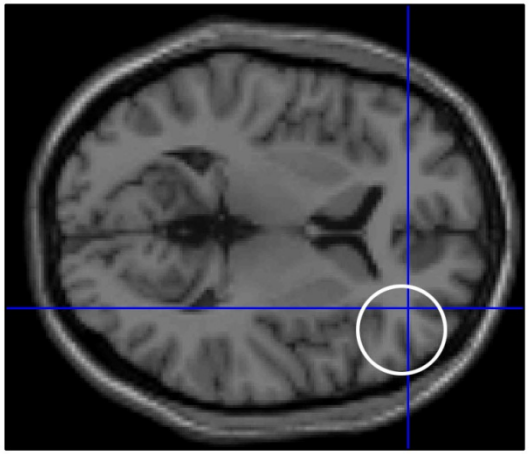
Reward: Probabilistic Reversal Learning Task



Controls



Smokers



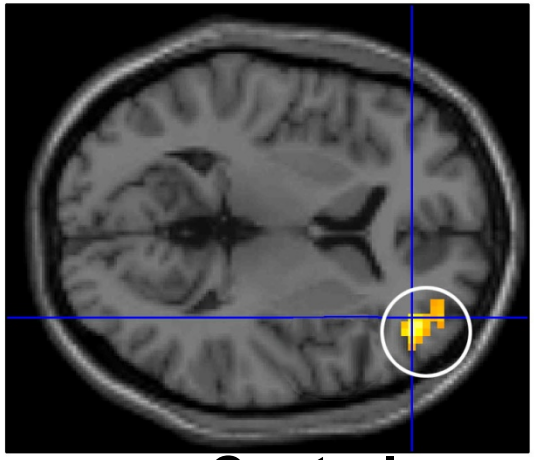
Problem Gamblers

Reward associated with activation Right VLPFC, Right Occipital/Parietal Cortex, Right Frontal Operculum, Bilateral Caudate Nuclues and Subthalamic Regions

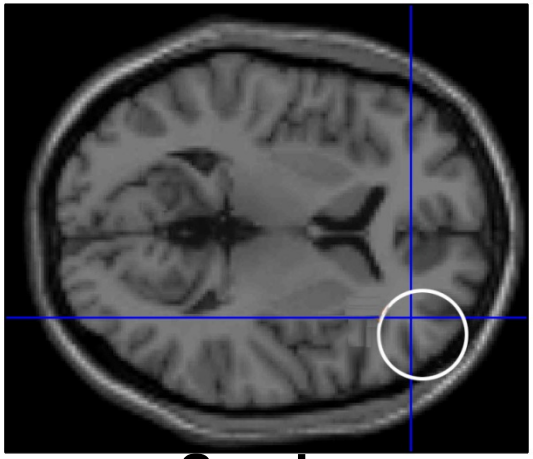
Significantly less activation of VLPFC in gamblers compared to smokers and controls (figures)

Findings similar to studies by Reuter (2005) and Tanabe (2007) who found reduced activation in PG in the VMPFC, a structure incompletely covered in our study. Similar finding in OCD (Remijnse, 2006)!

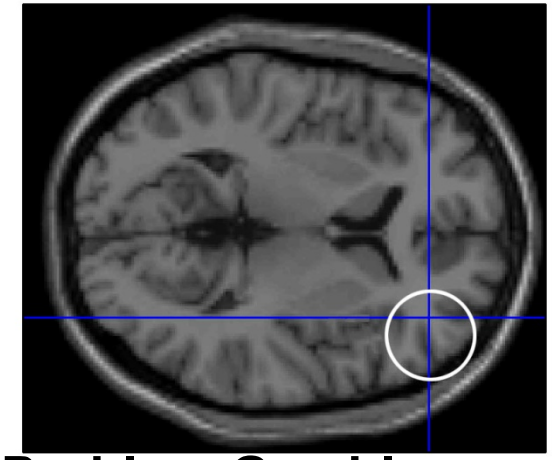
Punishment
Probabilistic Reversal Learning Task



Controls



Smokers

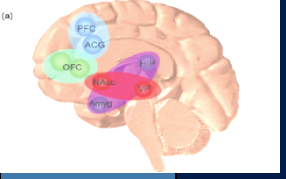


Problem Gamblers

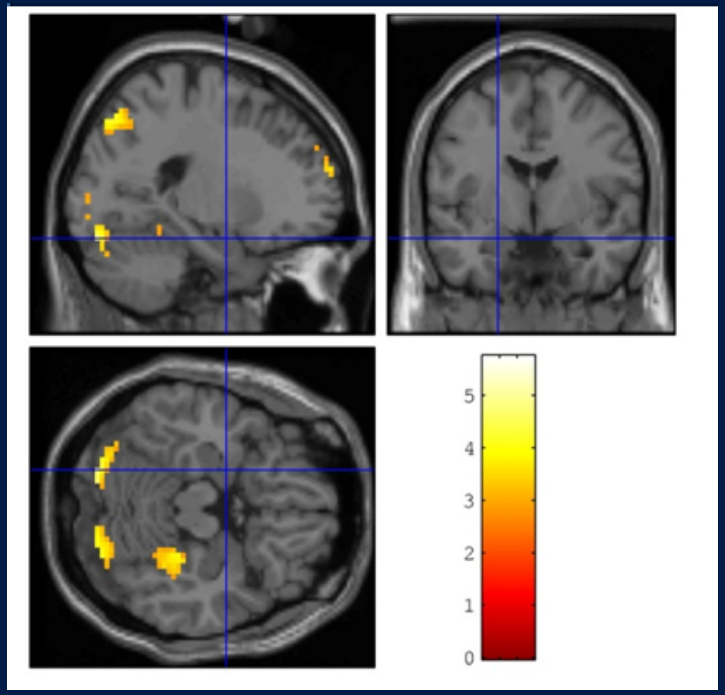
Loss associated with activation Right Frontal Operculum, Insula en Subthalamic Region

Significantly less activation VLPFC in smokers and gamblers compared to controls (figures)

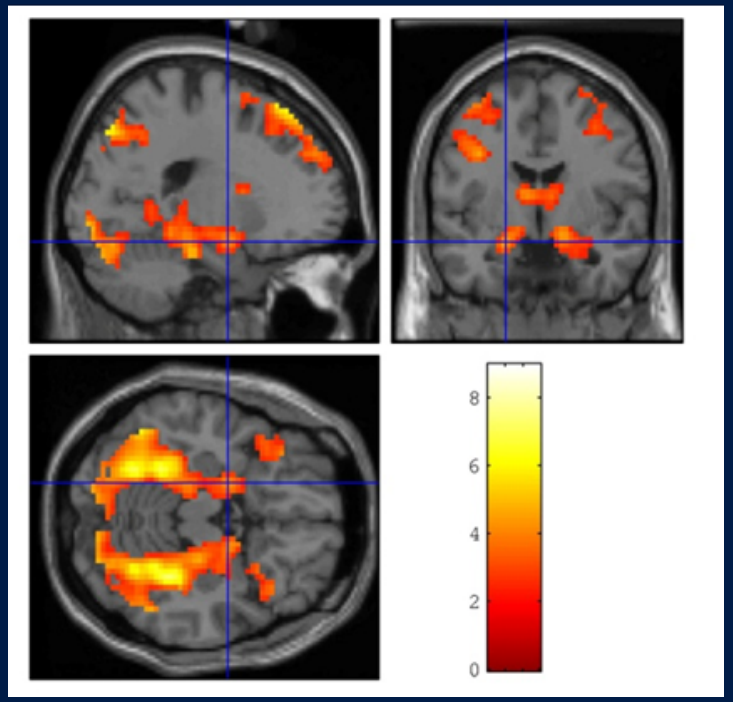
Cue reactivity in problem gamblers



Cue reactivity in problem gamblers



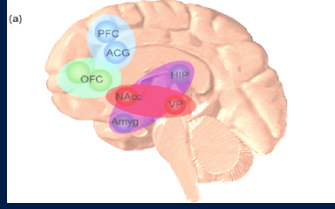
Control



Problem group Gamblers

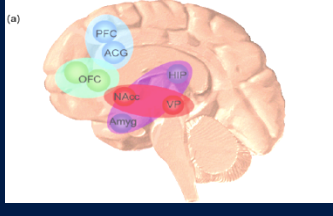
Ventral route, dorsal route,
Limbic: striatum, hippocampus, amygdala
More craving: higher activation in limbic areas

Goudriaan, De Ruiter, Veltman, Oosterlaan, van den Brink, 2009 (Addiction Biology)



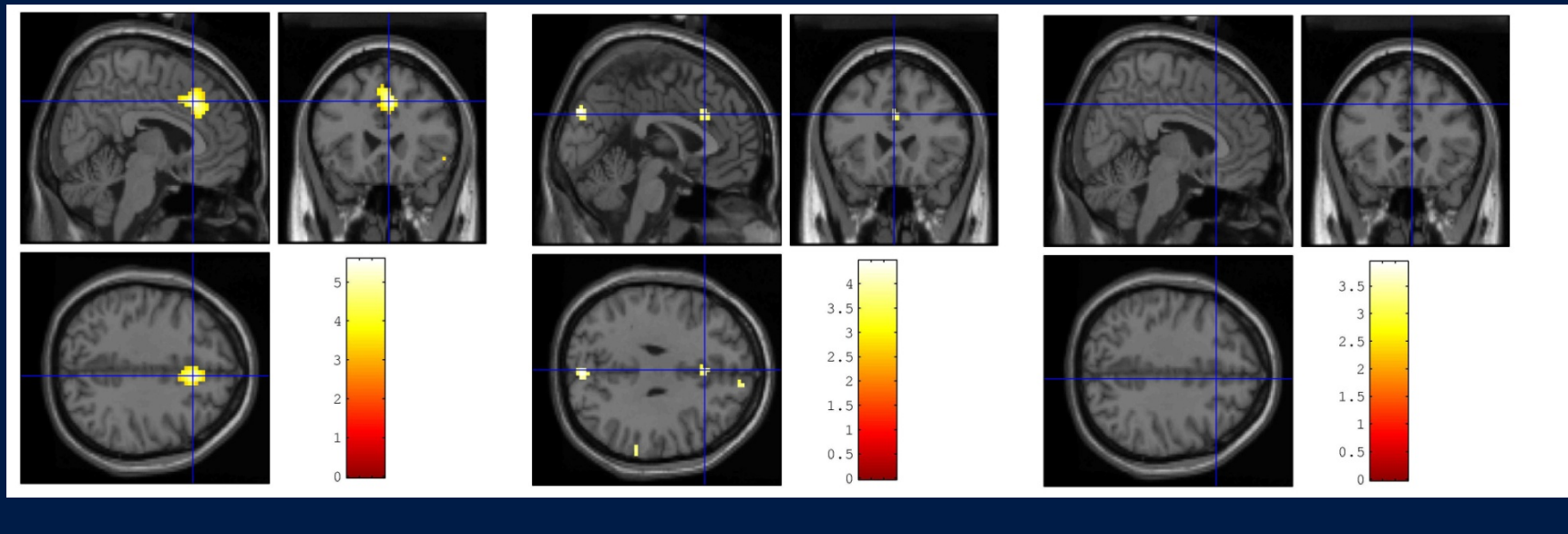
Error Monitoring: Stop Signal Task

OR



Error Monitoring: Stop Task

Activation in response to errors

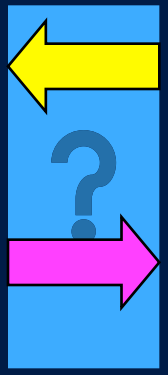


Controls **Smokers** **Problem Gamblers**

- Significantly less activation dACC following errors in gamblers compared to smokers and normal controls (figures)
- Finding consistent with Potenza et al (2003) - Stroop Task PG vs HC

De Ruiter, Oosterlaan, Veltman, van den Brink, Goudriaan, 2012, *Drug Alc Dep*

Differences?

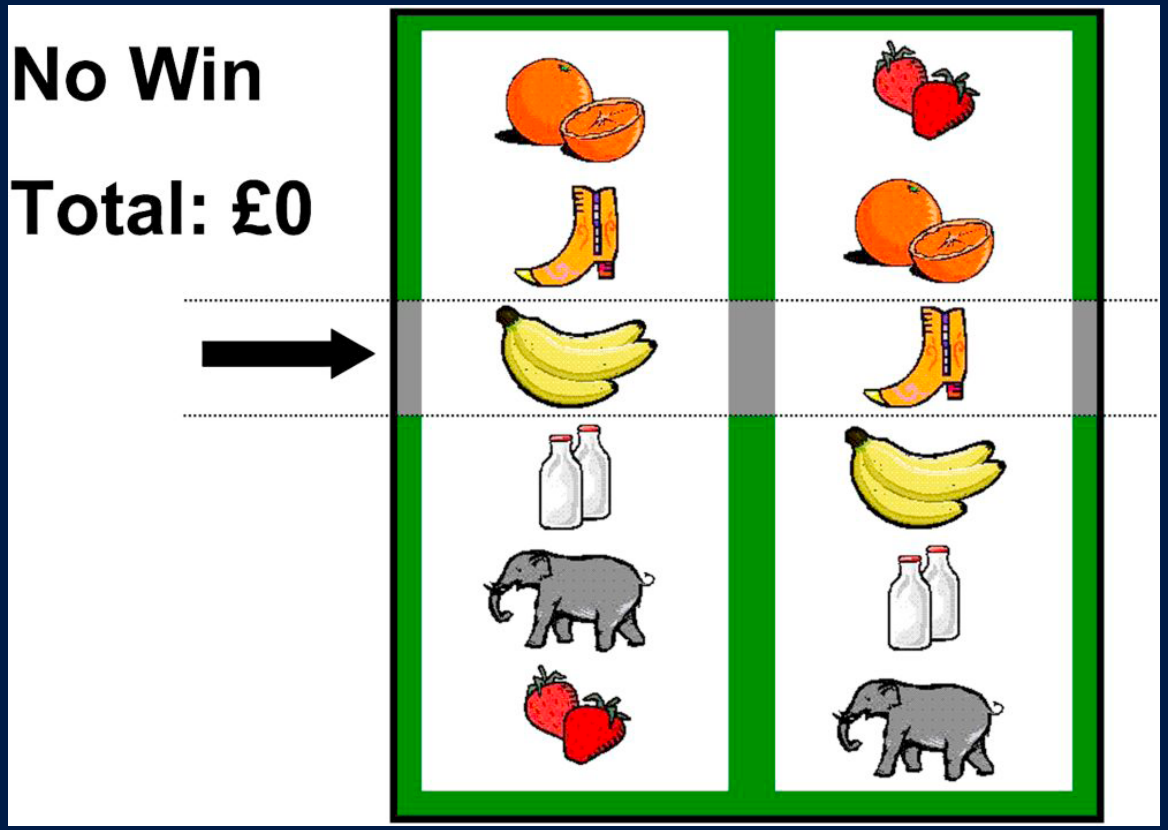


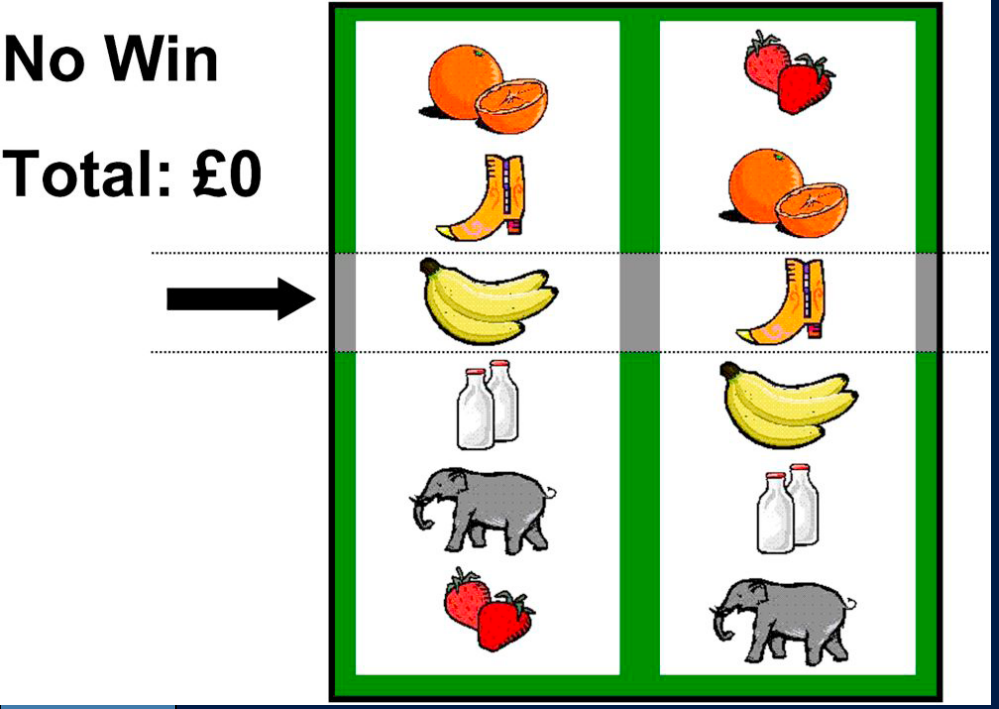
Slot machine gambling in MRI

Luke Clark[1,*], **Andrew J. Lawrence**[1], **Frances Astley-Jones**[1], and **Nicola Gray**[1]

[1]*Behavioural and Clinical Neuroscience Institute, Department of Experimental Psychology, University of Cambridge, CB2 3EB Cambridge, UK.*

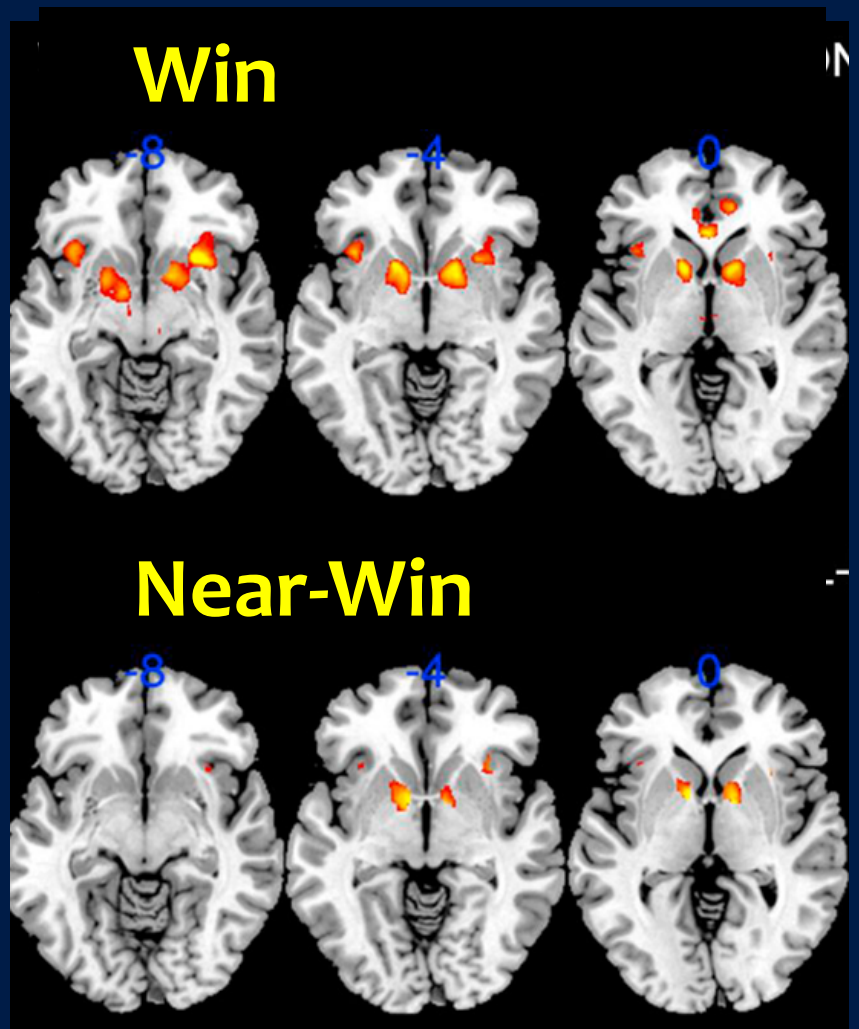
What is the effect of near wins in your brain?





- Stronger response to near-wins: stronger propensity to keep gambling

Clark, Lawrence, Astley-Jones, Gray, 2009

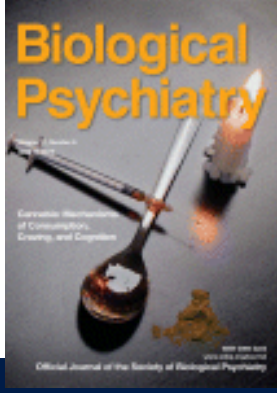


- What about the anticipation of winning?
- Does overestimation of winning play a role?

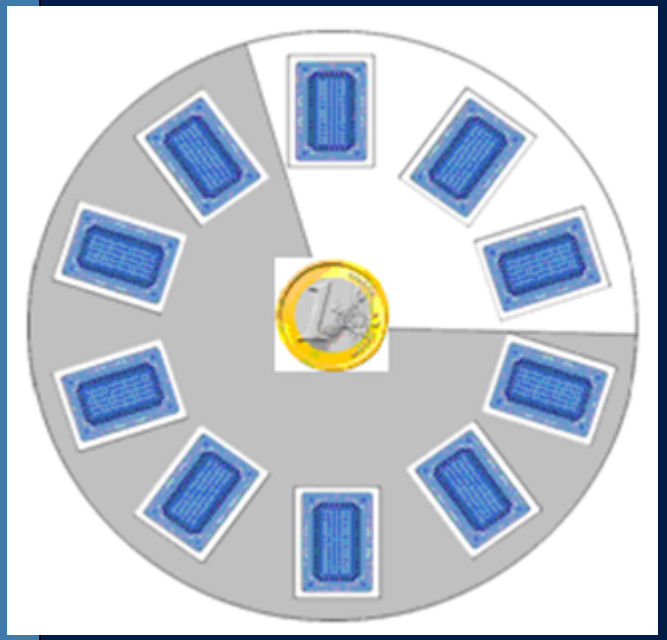
Archival Report

Distorted Expectancy Coding in Problem Gambling: Is the Addictive in the Anticipation?

Ruth J. van Holst[a, b], Dick J. Veltman[a, b, c], Christian Büchel[d], Wim van den Brink[a, b], Anna E. Goudriaan[a, b]



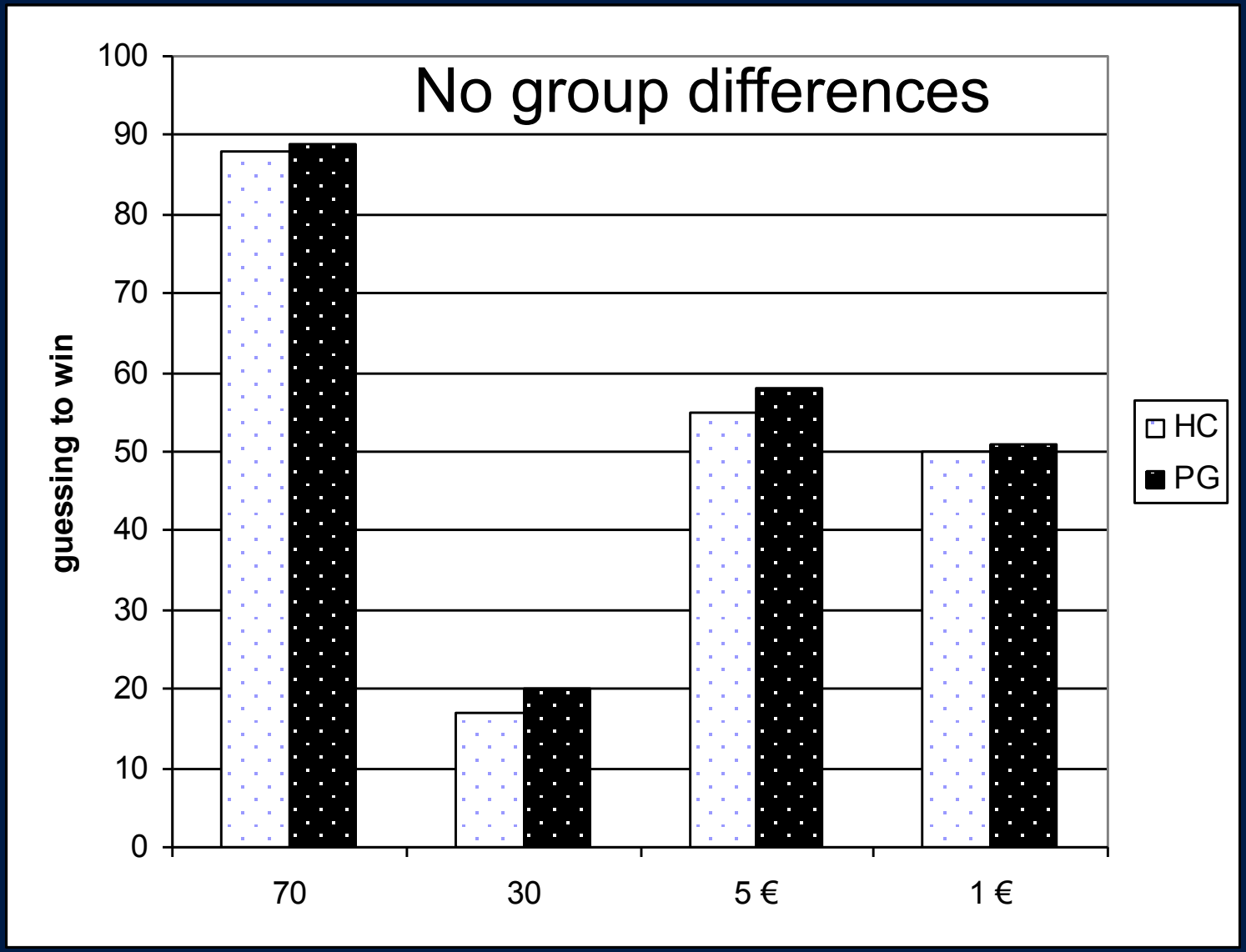
Win or lose?



WAIT

Van Holst, Veltman, van den Brink, Goudriaan, *Biol Psychiatry, 2012*

Behavioural results



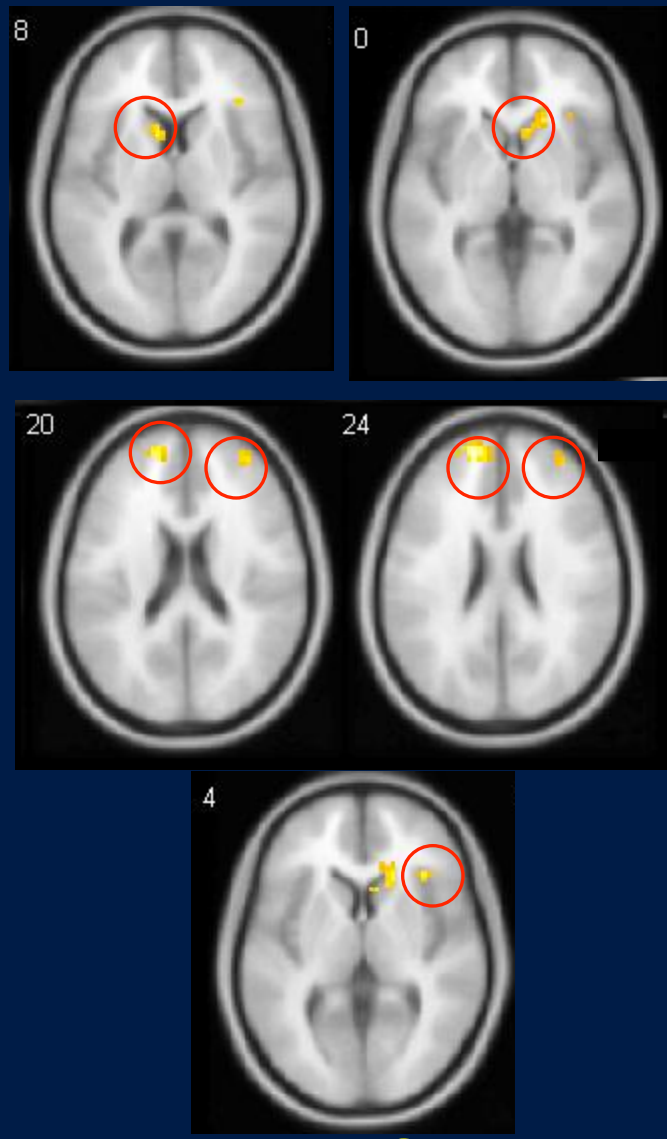
fMRI results: Expectation of winning

PRGs compared to HCs activate more brain reward areas:

-bilateral ventral striatum

-bilateral VMPFC

-left Insula

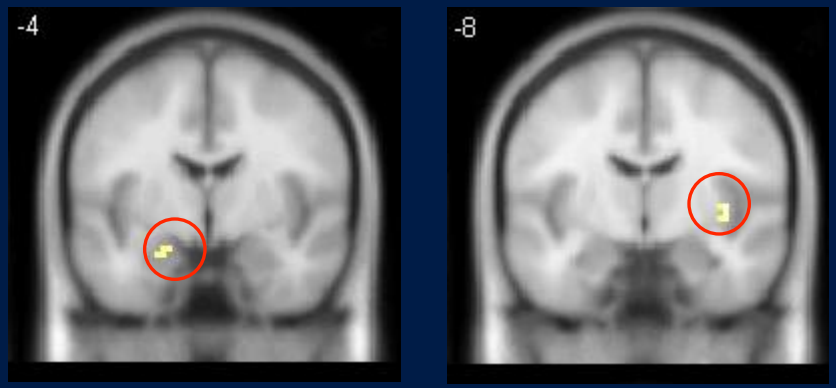


Van Holst, Veltman, van den Brink, Goudriaan

Biol Psychiatry – in press

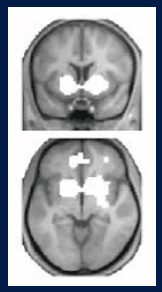
Expectation of losing

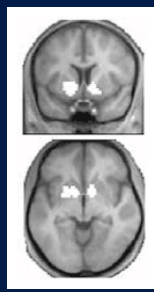
Both groups activate the left insula and right amygdala: no group differences

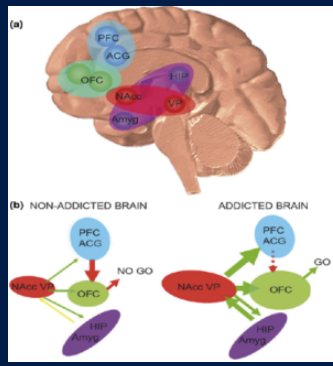


In summary, problem gamblers:

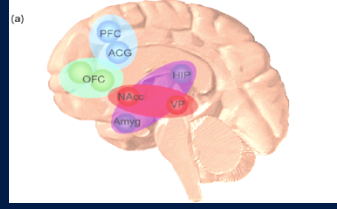
- Show less reactivity in reward areas during monetary gains (Reuter et al., 2005) and losses (De Ruiter et al., 2008)
- Show diminished activity of the cognitive control network during response inhibition (De Ruiter et al., 2012)
- show diminished executive functions in neurocognitive studies (Goudriaan et al., 2006; Lawrence et al., 2009; Ledgerwood et al., 2012)







Conclusions



The addictive is *also* in the

- **Near-win:** Recruit reward areas during near-misses (Clark et al., 2010)
- **Anticipation:** Problem gamblers show heightened activity in reward system during expectation of winning (Van Holst et al., 2012)
- Imbalance between control and motivation crucial for continued gambling (Reuter et al., Potenza et al., de Ruiter et al., Goudriaan et al.)
- Neuroimaging, neurocognitive, comorbidity patterns, genetics all point to similarities between PG and substance use disorders

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Thank you for your attention!

Questions…

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Questions and Discussion!

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Demographics

	PRGs (n=15)	HCs (n=16)	
Age, mean (SD)	**38.00** (13.42)	**34.92** (11.98)	T(26)= -0.92 *p*=0.37
SOGS, mean (SD)*	**10.00** (4.03)	**0.08** (0.28)	H(1)=19.33, *p*<0.001
BDI, mean (SD)	**8.87** (7.03)	**6.00** (4.04)	H(1)=1.91, *p*=0.16