

Neural responses to gambling and food-related images in pathological gamblers: a functional magnetic resonance imaging study

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1. Introduction

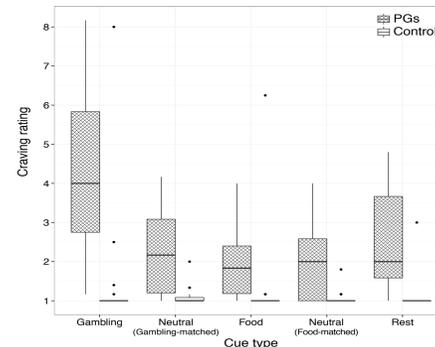
- Increased reactivity to addiction-related cues is important in the development of addictive disorders – **incentive sensitisation** (Robinson and Berridge, 1993).
- Existing fMRI literature suggests that networks involved in motivation and attention show increased activation in response to gambling cues in pathological gamblers (PGs) compared to healthy controls:
 - Crockford et al. (2005) - dorsolateral PFC, parahippocampal gyrus, visual cortex.
 - Goudriaan et al. (2010) - occipito-temporal regions, posterior cingulate cortex, parahippocampal gyrus.
- It is less clear how PGs may respond to natural rewards. During a modified version of the monetary incentive delay task, Sescousse et al. (2013) found that PGs showed a relatively blunted response during anticipation of erotic cues.
- The aim of the present study was to measure brain responses to Gambling cues and appetitive Food cues, in PGs and healthy Controls, using fMRI.

2. Methods



- We recruited 19 male PGs from the CNWL National Problem Gambling Clinic in London, and 19 matched Controls.
- We used a blocked design with four image categories (Gambling cues, Neutral cues matched to the gambling cues, Food cues, Neutral cues matched to the food cues) and rest blocks.
- Each block consisted of the presentation of 5 images from the same category (presented for 4.8s each) followed by a 1-9 rating (“I crave gambling right now”).
- We looked for changes in **activity** levels, and for changes in **functional connectivity** (PPI) with the nucleus accumbens.
- Gambling cue reactivity = Gambling cues vs. Neutral cues.
- Food cue reactivity = Food cues vs. Neutral cues.

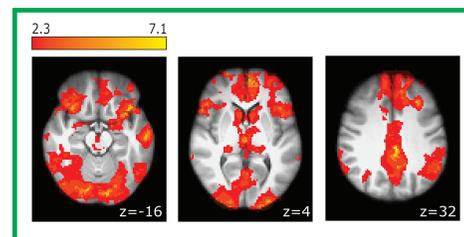
3. Results: Behaviour



- A three (Context: Gambling cues, Non-gambling cues, Rest) by two (PGs, Controls) ANOVA revealed a significant effect of Group, with PGs providing higher ratings than control participants, $F(1, 36) = 23.56, p < .001$, a significant effect of Context, $F(1.25, 45.01) = 21.15, p < .001$, and a significant interaction $F(1.25, 45.01) = 11.06, p < .01$.
- Planned contrasts revealed a significant effect of Gambling cues versus Non-gambling cues, $F(1, 36) = 24.38, p < .001$, and a significant interaction of this contrast with Group $F(1, 36) = 13.69, p < .001$. This interaction was driven by the relatively high ratings by PGs after Gambling cues.
- Gambling cues were also followed by higher ratings than Rest, $F(1, 36) = 20.47, p < .001$. There was a significant interaction of this contrast with Group, $F(1, 36) = 8.76, p < .005$. This interaction was again driven by the relatively high ratings by PGs after Gambling cues.

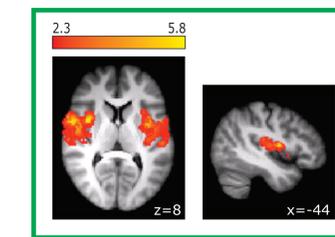
4. Results: fMRI

Gambling cue reactivity: PG group



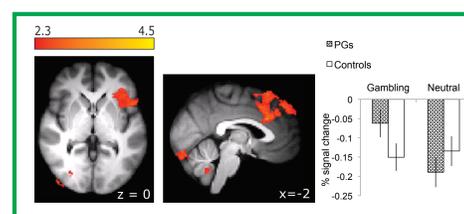
- Multiple regions showed increased **activity** to Gambling cues, including the posterior cingulate gyrus, the left superior frontal gyrus, the left frontal pole, the bilateral ventral striatum and medial PFC.

Gambling cue reactivity: Craving ratings in PGs

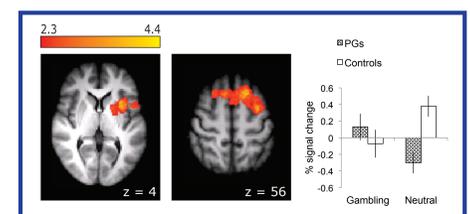
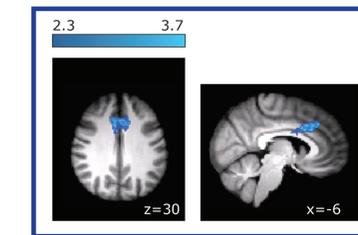


- Craving ratings provided after the Gambling cues were averaged across the experiment to create a value for each PG participant.
- These Craving ratings correlated:
 - Positively with **activity** in the bilateral insula
 - Negatively with **functional connectivity** between the nucleus accumbens and medial PFC.

Gambling cue reactivity: Group differences



- Multiple regions showed increased **activity** to Gambling cues in the PG group compared to the Controls, including the left operculum/insula, and the medial PFC.



- During Gambling blocks, PGs, compared to Controls, showed increased **connectivity** between the nucleus accumbens and two regions; the left insula and superior frontal gyrus.

Food cue reactivity

- Across all participants several regions showed increased activity to Food cues, including the occipital cortex, the paracingulate gyrus, the insula, and the anterior cingulate cortex.
- There were no group differences in Food cue reactivity at the whole brain level, or using a more liberal region of interest approach.

5. Conclusions

- Using a novel task we have found that, whilst viewing Gambling cues, PGs show increased activity in components of the motivational circuitry, and that the ventral striatum undergoes connectivity changes with regions of the prefrontal cortex. This provides support for the incentive sensitisation theory of addiction.
- Within the PG group, we found the bilateral insula showed a positive relationship with Craving ratings, and connectivity between the nucleus accumbens and mPFC decreased as Craving ratings increased.

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