



Nuances of the Reward System in Problem Gambling

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Problem Gambling: An Introduction

Gambling Disorder¹, a more clinically severe form of problem gambling, is often compared to substance use addictions because of similarities between the two populations. Specifically, they share overlap in the observed clinical symptoms and in research findings. For this reason (among others), research on gambling has borrowed from substance and alcohol use. One such topic where current gambling work heavily relies on drug addiction is the Reward System.

The Reward System consists of several brain areas working together to regulate individuals' reactions towards or away from rewards. For example, this could include feeling pleasure when scratching a lottery ticket or rolling a dice. The brain areas involved in this system are also important for motivation, decision-making and learning. Generally speaking, there are three main hypotheses that explain how the Reward System may be involved in addiction:

1. *Reward Deficiency Syndrome*: The reward system is hypoactive so the individuals look for external reward (such as money or drugs) to activate their reward network^{2, 3}.
2. *Impulsivity Theory*: The reward system is hyperactive so the individual is more likely to seek rewards^{4, 5}.
3. *Incentive Saliency*: There is a change from 'liking' the reward to 'wanting' it irrespective of whether the individual likes it or not^{6, 7}. At this point, the system is also hypersensitized to rewards^{6, 7}.

History: How Did it Start?

The Reward System includes a number of pathways and brain regions. In problem gambling research, the most studied brain regions are the ventral striatum (VS), the ventromedial prefrontal cortex (vmPFC), the orbitofrontal cortex (OFC), the anterior cingulate cortex, and to a lesser extent, the insula. Each of the different hypotheses predicts different "activation patterns" involving the brain regions of those with problem gambling and a substance-use disorder. These "activation patterns" differ depending on the nature of the task used. Further, there are two distinct phases of reward processing called 'anticipation' and 'outcome'. The anticipation period is when a person actively waits for the reward. The following outcome phase defines the moment when the individual gets the reward. Individuals can experience anticipation and outcome in tasks that involve wins and losses^{8, 9}.

There are two main camps describing the Reward System during both of these phases. The majority of studies show decreased activity in certain brain regions^{10, 11} supporting

Key Message

Traditionally, the Reward System in drug and gambling addictions are similar when considering the brain regions involved and the different hypotheses that predict how they respond. However, advancements in gambling research - research questions, better methods and superior technology - show that both of these addictions are dissimilar. Within gambling research, the different subtypes and motivations that lead to problem gambling further complicate the findings. Future work needs to consider: 1) this variability, 2) the possible effect of experimental protocol, and 3) population-specific demographics. These innovations in the Reward System will inform research and treatment strategies, including personalized medicine, as well as policy-making.

a hypoactive Reward System. However, others suggest a hyperactive Reward System because of evidence showing an increased release of dopamine^{12, 13} (an important, organic chemical involved in processing rewards²⁻⁷) within these brain regions.

Regardless of the activation patterns, both camps agree to an overall increased sensitivity toward rewards, an effect driven by prior losses¹⁴ and a decreased sensitivity towards non-gambling rewards (such as erotic stimuli¹⁵). In other words,

gamblers may be more sensitive to gambling rewards and less to other types of rewards – perhaps leading them to seek out gambling over other rewarding behaviours. The implications of these findings have been a hot topic of debate.

In order to attempt to parse out the fine details, current work addresses the following questions:

- How similar and different is the Reward System in substance use and gambling addictions?
- Can the different hypotheses be reconciled when studying the Reward System in gambling addiction?
- What are the consequences of differences in types and preferences of rewards?

Current Status of the Science of Gambling

There are two likely reasons for the different findings in reward processing research:

1. There exists “subtypes” of problem gamblers, with each responding differently to rewards.
2. Dissimilarities in tasks and approaches used across studies lead to different results.

First, in terms of subtypes, there may be three pathways leading to the development of problem gambling: 1) behaviourally conditioned to gambling, 2) emotionally vulnerable, and 3) antisocial and impulsive¹⁶. Each of the pathways is driven by different motivations and these may play out as differences in reward sensitivity.

Second, the dissimilarities in tasks and approaches - technical tools combined with the variety of behavioural and neurocognitive tasks - used to measure and assess reward processing may lead to diverse results. Two popular tools used are functional Magnetic Resonance Imaging (fMRI) and electroencephalography [EEG]), where the former measures function and the latter the electrical activity of the brain.

A recent analysis of multiple fMRI studies investigated reward anticipation and outcome phases across several studies that used different reward tasks¹⁷. They found a hypoactive Reward System in those with a Gambling Disorder when expecting and receiving rewards. However, in substance-use addiction, this network was only hypoactive during reward anticipation. Clearly, despite theoretical and clinical similarities between these addictions, they

are not completely alike. This stresses the importance of exploring the Reward System across addictions independently and of investigating the changes within this system with the use of similar versus diverse methods.

In addition to differences in activity discussed in the previous section, there are distinctions in the strength of the connection between the brain regions in the Reward Network. For example, one study¹⁸ shows an imbalance in activity within and between brain regions, leading to differences in response towards gambling versus non-gambling rewards. Age-related changes also play an important role because it affects other features of problem gambling, such as impulsivity¹⁹. In light of complicated biological changes, it becomes increasingly relevant to explore population-specific demographics as well.

Canadian Perspective

Over the past decade, research groups in Canada have applied diverse strategies and tools to investigate the Reward System in problem gambling. Some of the groups include:

1. Gambling researchers at CAMH explore the interactions between pharmacology and dopamine release^{13, 20}, and how that affects learning²¹.
2. The Centre for Gambling Research at the University of British Columbia focuses on the motivational and cognitive processes underlying near misses and craving²²⁻²⁴.

The common focus has been on understanding the Reward Network by tackling it from multiple angles, such as reward-related cognition and behaviour, using neuroimaging, neurocognitive tasks and pharmacological manipulations. Similar to gambling work elsewhere, Canadian research also faces methodological and categorical concerns.

Limitations & Future Directions

Over the last five years, work on the Reward System in gambling addictions has flourished. Research work has started to explore distinct responses in the Reward Systems of those with a gambling addiction when compared to those with a substance-use addiction. Despite these recent advances, there is still a lot of comprehensive work to be done. The activity within this network is different depending on the type of task used. This leaves us with questions on whether these disparities are telling of the addictive brain or of the method used.

It is important to tackle these gaps and questions to provide a more comprehensive view of Gambling Disorder:

- How sensitive are the observations on the Reward System to differences across the study paradigms?
- What would research find if gambling “subtypes” categorized the study of the Reward System?
- How does the Reward System differ between sexes (male, female) and gender identity (male, female, transgender, others)?

These advances on moving towards a more specific Reward System will inform treatment strategies, including personalized medicine.

About the author

Fiza Arshad completed an Honors BSc degree in the Neuroscience program at the University of Toronto in 2015. Presently, she is an MSc Candidate training at the Peter Boris Centre for Addictions Research under the supervision of Dr. Iris M. Balodis at McMaster University. Her research interests include exploring the neurobiological and physiological basis of stress and behavioural inhibition in problem gambling.

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