The Neuroscience and Neuropsychology of Gambling and Gambling Addiction: an Introduction to the Special Issue

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Abstract:

Neuroscience research on gambling, including neuropsychological, neuroimaging, and psychophysiological experiments, is often regarded as aligned with the 'brain disease model of addictions'. We assert that a bio-psycho-social framework represents the consensus view of disordered gambling, giving equal weighting to biological and psychosocial predisposing factors (and their interactions). Within this framework, we highlight three ways in which neuroscience can inform gambling research - none of which rely on one's endorsement of biological 'causal

explanations': i) as a toolbox of objective measures for studying gambling behaviour, ii) as a way of understanding treatment mechanisms, of both psychological and biological treatments, iii) as a way of probing the impact of gambling product features relevant to gambling policy.

Keywords: neuroimaging, neurobiology, biopsychosocial, decision-making, behavioural addiction.

We are delighted to introduce this Special Issue of *International Gambling Studies* dedicated to the neuroscience and neuropsychology of gambling and gambling addiction, featuring a combination of review articles on contemporary topics and original research papers, from leading groups in the field. In some respects, this Special Issue is published at a curious time, with something of a backlash in progress against biomedical models of addictions. At a major gambling conference in February 2018, the author Johann Hari opined that neuroscience explanations of addictions were akin to examining the plot of Romeo and Juliet in terms of the molecules that were moving in the protagonists' bodies, and that this was, in his view, an inappropriate level of explanation for addictive disorders. Instead, Hari presents a case for the primary (and in his view neglected) role of psychosocial factors including early adversity and social connectedness (Hari, 2015).

Gambling Disorder as a biopsychosocial disorder

The 'brain disease model of addictions' has been positioned by some as the dominant school of thought in addiction science over the past 20 years (e.g. Hall, Carter, & Forlini, 2015; Heyman, 2009). This perception varies across countries, but nevertheless, it has also received robust

critique. For example, it is clear from epidemiological research that many individuals suffering from substance addictions must undergo spontaneous recovery without engaging with treatment services, which does not fit easily with a theory based on a chronic, brain-based illness (Heyman, 2009). It has been argued that sustained funding of neuroscience research on addictions has yielded negligible advances in pharmacotherapy (Hall 2017). Given that substance addictions are characterized by marked neural changes, which are partly the result of chronic consumption, and that these neurotoxic effects are presumably absent in people with gambling problems, these concerns may be even more pertinent to research on disordered gambling.

Much of this debate is about extreme positions that assert a primary role to one set of factors (e.g. biological factors versus psychosocial factors). In our view, this is a fight between two straw men. The majority of gambling researchers, cognitive neuroscientists, and mental health professionals working with people with addictions endorse a bio-psycho-social framework. Indeed, we believe this approach has been well-established in the gambling field since at least the introduction of the Pathways Model (Blaszczynski & Nower, 2002; Sharpe, 2002). The tenets of this framework are: 1) disordered gambling is maintained (in the moment) by psychological processes that include both behavioural mechanisms (e.g. operant conditioning based on variable reward) and cognitive mechanisms (e.g. faulty beliefs about randomness), 2) individual biological (e.g. heritability) and/or psychosocial factors (e.g. childhood adversity, early gambling exposure) make some individuals undergo the transition from recreational to disordered gambling more easily. The relative ordering of the factors in the name of the approach is meaningless, and we would encourage a roughly equal distribution of research across the 3 factors.

Can neuroscience and biobehavioral research provide new avenues?

Where does this leave contemporary research on the neuroscience and biobehavioral mechanisms of gambling? We propose 3 ways in which neuroscience experiments can illuminate gambling research, and importantly, these 3 principles are independent of one's perspective on biological 'causal explanations'. The first area of research – and one that is capably evidenced in each of the articles in this Special Issue – is that neuroscience provides a toolkit of techniques for studying gambling behaviour. This toolkit includes functional and structural brain imaging, electroencephalography, peripheral psychophysiology (e.g. heart rate) and hormone measurements (e.g. cortisol, testosterone), and these techniques each require firm grounding in behavioural analysis (e.g. task-related fMRI). These tools help to overcome a range of problems with the main alternative technique, self-report, which is introspective, often retrospective, and susceptible to numerous forms of bias including demand characteristics and social desirability. As a concrete example, craving is an important clinical, experiential phenomenon in people with gambling problems (Cornil et al., 2018), but the measurement of craving by self-report alone can be complex, due to the biases mentioned above, as well as high levels of 'alexithymia' (difficulty in recognizing emotion or bodily arousal) in problem gamblers (Noël et al., 2017). As a result, self-reported craving and cue reactivity to addiction-related cues are only moderately correlated. By augmenting self-report measurements with behavioral and brain imaging measures, we are able to see the biobehavioral and neural signature of this state both in terms of brain activation and brain communication (connectivity), which overlaps with other data on cravings in substance addictions (Goudriaan, de Ruiter, van den Brink, Oosterlaan, & Veltman, 2010; Limbrick-

Oldfield et al., 2017). Brain responses to cue reactivity have also been employed as a biomarker for treatment development, such as the opioid antagonist naltrexone (Myrick et al., 2008).

This brings us to a second area of research, concerning new avenues for treatment. In the case of animal models for Gambling Disorder, new findings from behavioural neuroscience may directly highlight new options for medication development, such as dopamine agents that more selectively bind to D3 and D4 receptors (Di Ciano & Le Foll, 2018). Indeed, the most compelling evidence that biological factors *causally* influence the expression of disordered gambling is the emergence of impulse control disorders in patients with Parkinson's Disease, as a side-effect of dopamine agonist medications and especially drugs with a high dopamine D3 affinity (Moore, Glenmullen, & Mattison, 2014). However, a popular misconception is that neuroscience research *only* informs medication development. On the contrary, neuroscience research can also shed light on the mechanism of action of psychological treatments for Gambling Disorder, and thereby be used to further enhance these forms of treatment. For instance, executive dysfunction associated with diminished prefrontal cortex functioning may compromise a patient's ability to implement aspects of cognitive behavioral therapy, such as the use of strategies to cope with high-risk situations. Cognitive protocols geared at improving executive functions, such as goal management training, have shown promising results in pilot studies in substance use disorders (Valls-Serrano, Caracuel, & Verdejo-Garcia, 2016). Neuroscience research may inform the mechanisms underlying cue exposure therapy, a core component of behavioural therapy for which evidence of effectiveness in substance use disorders remains inconsistent (Mellentin et al., 2017). The investigation of psychophysiology during

virtual reality gambling exposure has also illuminated factors (e.g. number of sessions; type of environment; effect of mood) that influence positive clinical response (Bouchard et al., 2017).

The third area of research relates to gambling policy. With the international expansion of gambling, there is a growing need to understand which forms of gambling present higher risks, and which specific structural characteristics of gambling games underpin those risks. As articulated in a recent article by Yucel and colleagues (Yücel, Carter, Harrigan, van Holst, & Livingstone, 2018), "The relative influence of one design feature over another is unclear, but the combined effects probably impart a powerful drive towards gambling-related thoughts and behaviour" (pg 20). The challenge that this presents to researchers is hugely complex: do we investigate each design feature in isolation, searching for critical addictive ingredients, or do we focus on the summed effects that arise in real-life gambling situations, such as in-game immersion? A detailed understanding of the neural and behavioural impacts of gambling games, and the relevant dimensions of human individual differences in these effects, will provide a foundation for producing safer gambling products. Implementing this knowledge in the form of responsible gambling practices also benefit from dialogue between gambling researchers, gambling regulators, and gambling operators, who can in turn support research through facilitating access to data and realistic gambling products, especially in the context of electronic gaming machines (EGMs) and online gambling.

Conflict of interest statement:

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