

## **Editorial Overview: Apathy and Motivation**

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Lack of motivation is increasingly recognized to be a major, debilitating symptom across a wide range of brain disorders. It impacts upon quality of life for patients and their families, is often associated with a poor prognosis for functional independence and can be a marker for disease severity. In the neurological literature, lack of motivation is often referred to as ‘apathy’, but very similar symptoms are often referred to as ‘negative symptoms’ by researchers of psychiatric diseases, such as schizophrenia. Strikingly, symptoms of amotivation – regardless of the brain disease in which it manifests – have proven to be very difficult to treat. Indeed, there are no established successful therapies for either apathy or negative symptoms.

New developments in the basic neurosciences and experimental medicine studies in patients have begun to elucidate some of the fundamental brain mechanisms and circuits underlying motivated behaviour, and their disruption in disorders of motivation. In this special issue, we bring together some important examples of these approaches in an attempt to provide a wide-ranging overview of both animal and human research in this exciting field. Our ambition has been to give readers a perspective which cuts across traditional boundaries to allow a broader view of common themes that exist in different fields.

Therefore, for insights into the clinical syndromes of amotivation, we have taken a trans-diagnostic approach, inviting reviews on diseases that are traditionally considered ‘psychiatric’ as well as those that are termed ‘neurologic’. There are contributions on disorder of: motivation in schizophrenia ([Clubreth et al](#); [Hartmann-Riemer et al](#)), anhedonia in both adults ([Cooper et al](#)) and adolescents ([McCabe](#)) with depression, stress in depression ([Ironsides et al](#)), Alzheimer’s disease ([Nobis and Husain](#)), frontotemporal dementia ([Passamonti et al](#); [Johnson and Kumfor](#)), and neurodegenerative diseases more widely including Parkinson’s disease and amyotrophic lateral sclerosis or motor neuron disease ([Radakovic and Abarhams](#)).

Several of these perspectives consider the possibility that deficits in effort-based decision making, including alterations in effort allocation for reward, might underpin

aspects of amotivation in these very diverse patient populations. Effort is one of the key phenotypes discussed by Pessiglione et al. in their overview of the approach of fitting computational models to patient behavioural data, and then studying how the models “behave” in order to better understand the neurobiology underlying motivational deficits. Such considerations build directly upon a wide body of research in the animal literature, reviewed here by [Salamone and Correa](#), which have used effort-based decision making tasks as objective measures of motivated behaviour.

[Slaney et al.](#) extend the consideration of rodent decision-making to those translational tasks developed to investigate deficits in positive bias for reward-associated stimuli, whilst Phillips et al. discuss the application of touch-screen technology to the translational study of reward-directed behaviours in rodents. The major advantage of valid animal models of reward processing and pathology is the causal study of aetio-pathophysiological pathways; Vichaya and Dantzer illustrate this by presenting the evidence for inflammation as a powerful inhibitor of effortful motivation.

Many studies using paradigms that probe effort-based decision making have implicated dopamine as a key neurotransmitter involved in modulating behavioural activation and effort-based decision making where physical effort has to be allocated. [Westbrook and Frank](#) consider also how dopamine might play a role in the control of the allocation of cognitive effort, emphasizing a possible special contribution to proximal goals. The costs of cognitive control are scrutinized further by [Froböse and Cools](#) who discuss the evidence regarding noradrenaline and serotonin as well as dopamine in affecting willingness to exert such control.

[Chong](#) discusses the contribution of dopamine in the learning and valuation of effort and reward, and how different aspects of dopamine signals might contribute to different aspects of apathetic behaviour via these processes. For it has become clear that apathy might not simply manifest as lack of initiation of behaviour but also in terms of emotional blunting or willingness to engage in social interactions ([Radakovic and Abarhams](#)). Olney et al. highlight the importance of differentiating between motivation (wanting) and hedonic impact (liking) in the study of reward-directed behaviour and apathy thereof. To

date these other dimensions of apathy have received far less interest in terms of experimental studies. However, some research in both animals and humans may be of relevance to future work in this area.

With regards to involvement of specific brain areas in the circuitry of reward-directed behaviour, Pryce considers the role of the amygdala – a key node in the network that regulates emotional response – in processing reward valence and salience, while Soutschek and Tobler focus on brain mechanisms underpinning willingness to accept and overcome costs in social settings, providing a new way framework to understand these. Kolling and O'Reilly discuss the concept that certain cortico-limbic structures of the human brain function to enable optimal decision-making with respect to obtaining rewards across time.

Overall, therefore, this issue provides a timely insight into the concepts and methods being used to study motivation and apathy in the behavioural sciences generally and the clinical fields of psychiatry and neurology specifically. It demonstrates the trans-diagnostic importance of these behavioural processes and their pathologies, and provides numerous examples of how neurobehavioural understanding is increasing. It is to be hoped that this knowledge will lead to much-needed improved treatment strategies in the near future.