

## **Predictive Patterns of Human Behaviour: An Analysis**

The concept of predictive patterns of behaviour is at the forefront of neurobiological research currently; however, its use in practice is largely limited due to differences in understanding of the field by different researchers and practitioners. Several theoretical frameworks that have been proposed in this context vary highly in their approaches, making it difficult to adopt any one theory for practice. This paper aims to compare the different views of the field focusing on how physiology and mental programming contributes to predictive patterns of behaviour, and how this influences an individual's behaviour dramatically.

Modeling of human behaviour is a topic that is of great interest to psychiatrists as well as in the commercial sector due to several reasons. Mechanisms that can predict patterns of human behaviour can also predict the possibility of actions such as click, buy, or call. Prediction of human behaviour patterns can be applied to different sectors such as politics, healthcare, psychology, personal life, e-commerce, and financial risk. However, most of the algorithms or models that are used for predicting these human patterns of behaviour do not throw light on the mental or physiological mechanisms that lead to these predictive behaviour patterns in an individual (Phan et al., 2016).

One explanation for predictive patterns of human behaviour is that it depends on the mutual interaction between several factors such as environmental influences, social events, and self-motivation. This theory is known as the 'human agency in social cognitive theory'. This theory not only explains behaviours in the context of social and environmental influences, but also enables the prediction of future behaviours provided the same social and environmental scenario is recreated (Phan et al., 2016). Another explanation is more biological in its origin and is called the 'process model'. This theory proposes that mental processes in all animals possessing a central nervous system are deeply intertwined with the challenges faced by an individual in the context of both reproduction and survival. According to this model, all individuals are heavily dependent on their environment for directing their behaviour, thereby making it predictable (Greve, 2015).

The underlying mental processing that gives rise to predictive behaviour patterns is highly complex. The perception processes of individuals have been described as a cascade of inference loops where the input sensory information is compared with responses that have been generated earlier in each loop, which directs the future behaviour of the individual. If significant differences are detected in earlier responses stored in the loops, all of these responses are used in predicting the individual's future behaviour. This form of hierarchical predictive coding has been shown to be in the form of Bayesian probability calculus and has been described in detail by Karl Friston (Friston, 2003).

An interactivist approach has been proposed by Mark Bickhard and Donald Campbell, which is process-oriented rather than substance-oriented, and is in stark contrast to the input-processor model of predictive patterns of behaviour. It considers anticipation to be an essential element of predictive behaviour and gives a lot of importance to the concept of normativity (Bickhard and Campbell, 2003). Another model proposed by Greve (2015) follows several tenets of this interactivist approach; however, it differs in the fact that it focuses heavily on biological plausibility by considering survival to be the main cause for predictive patterns of behaviour.

Predictive processing and prediction-based generative modeling have been dwelled upon extensively using the human brain as a model which generates predictive behaviour patterns. Each individual brain has its own model of the world by using generative modeling, wherein the brain moves backward by analysing information in the context of external stimuli that led to the generation of that information. Several *a priori* models are used for this purpose that house information about typifications and ideal types present in the social environment. However, the world is an ever-changing place and every action taken is aimed at eliminating the harmful effects of the external environment. Therefore, anticipation plays an important role here where harmful environmental effects are anticipated and specific actions are taken on the basis of information already stored in the brain. Predictive processing is used to identify inconsistent and ambiguous data and to remove noise from the information received by

the brain. In this way, the brain stores information, interprets it, and gives commands for predictive behaviour patterns in an uncertain environment (Kelly et al., 2018).

Behaviour Change Interventions (BCIs) have been developed to bring about significant changes in human behaviour patterns. They may be in the form of policies, services, activities, or products designed to bring about dramatic changes in the predicted behaviours of individuals. The targets for these interventions include knowledge, beliefs, skills, habits, and feelings of individuals with respect to their physical and/or social environment. The objective of these interventions is usually to produce a change that is sustained for a sufficiently long duration such as reducing or eliminating the habit of substance and alcohol abuse, or encouraging people to buy a particularly innovative product (Michie et al., 2017).

In practice, the behaviours that are targeted for change vary widely from reduction or elimination of negative behaviours to enhancing the incidence of positive behaviours in individuals. As a result, the specific interventions that bring about a change in predictive patterns of human behaviour also need to be tailored based on the type of behavioural pattern and the desired changes to it. Therefore, the interventions may vary from increasing taxes and excise duty on unhealthy products such as drugs to mobile applications for promoting a healthy lifestyle through diet, exercise, and medication adherence. The interventions may also vary with the population that is targeted, for instance the interventions that are applied to the general population may not work for people having significant physical or mental health problems (Michie et al., 2017).

The need for BCIs in our community is quite important because predictive patterns of behaviour such as unhealthy dietary practices, smoking, and alcohol consumption have been proposed to be some of the leading causes of death globally. Interventions practiced at the community level can have major impacts for health outcomes worldwide. These interventions that aim to encourage positive healthcare practices often target behavioural risk factors such as smoking, promote protective behaviours such as health screening camps, promote adaptation to diagnosed health conditions through medication adherence, and alter healthcare workers' behaviours to

improve the quality of healthcare services. Despite best efforts, the interventions that have been reported to have positive outcomes in the field of healthcare have shown to produce only modestly significant effects at the community level (Davis et al., 2015).

Contrary to health-oriented interventions, it has been extensively proved that digital BCIs are more successful at bringing about changes in individual health-related behaviours. An important reason for this is that the success of any BCI depends on its ability to engage the individuals to a considerable extent. Therefore, current research focuses extensively on how to drive engagement in order to achieve highly positive outcomes. Some of the important factors that drive this engagement include time spent with the intervention, the number of times that the intervention has been accessed by an individual, and the number of times that the intervention has connected to web pages. Each of these factors has been well addressed and evaluated in order to improve the engagement that an individual has with an intervention (Ainsworth et al., 2017).

Interventions that have dramatic consequences are evaluated in light of observed usage and behavioural outcomes while making use of a minimum threshold for change. For example, studies have evaluated digital mental health interventions for session usage and content usage, in order to assess the efficacy of the intervention. Additionally, the “Reach, Effectiveness, Adoption, Implementation, and Maintenance” (RE-AIM) theoretical framework is also widely used to evaluate the success level of an intervention. Minimum threshold values may change for different target groups; however, such frameworks can give immense insights into the level of change that is caused by behavioural interventions on predictive patterns of behaviour (Ainsworth et al., 2017).

In conclusion, this paper covered the various theories and models that explain predictive patterns of human behaviour with respect to physiological and mental processing. Different theories propose different approaches and each of these approaches have been applied in varied contexts. Despite this diversity, some of the common elements in all these theories are anticipation, relationship with the environment, and normativity. These essential elements make it easy for researchers to design behaviour change interventions for altering individual behaviours with potentially

harmful effects. For instance, harmful health behaviours such as smoking, alcohol abuse, drug usage, and unhealthy dietary practices result not only in harmful consequences for the individual, but also cause a huge financial burden on the healthcare system of a country. Therefore, altering these predictive behavioural patterns in individuals can lead to an overall reduction in the number of people diagnosed with chronic health conditions. In this context, several factors that surround these interventions and theories that explain and evaluate them have been discussed in this paper.

## References

- Ainsworth, B., Steele, M., Stuart, B., Joseph, J., Miller, S., Morrison, L., . . . Yardley, L. (2016). Using an Analysis of Behavior Change to Inform Effective Digital Intervention Design: How Did the PRIMIT Website Change Hand Hygiene Behavior Across 8993 Users? *Annals of Behavioral Medicine*, *51*(3), 423-431. doi:10.1007/s12160-016-9866-9
- Bickhard, M. H., & Campbell, D. T. (2003). Variations in variation and selection: The ubiquity of the variation-and-selective-retention ratchet in emergent organizational complexity. *Foundations of Science*, *8*(3), 215-282.
- Davis, R., Campbell, R., Hildon, Z., Hobbs, L., & Michie, S. (2014). Theories of behaviour and behaviour change across the social and behavioural sciences: A scoping review. *Health Psychology Review*, *9*(3), 323-344. doi:10.1080/17437199.2014.941722
- Friston, K. (2003). Learning and inference in the brain. *Neural Networks*, *16*(9), 1325-1352. doi:10.1016/j.neunet.2003.06.005
- Greve, P. F. (2015). The role of prediction in mental processing: A process approach. *New Ideas in Psychology*, *39*, 45-52. doi:10.1016/j.newideapsych.2015.07.007
- Kelly, M. P., Kriznik, N. M., Kinmonth, A. L., & Fletcher, P. C. (2018). The brain, self and society: A social-neuroscience model of predictive processing. *Social Neuroscience*, *14*(3), 266-276. doi:10.1080/17470919.2018.1471003
- Michie, S., Thomas, J., Johnston, M., Aonghusa, P. M., Shawe-Taylor, J., Kelly, M. P., . . . West, R. (2017). The Human Behaviour-Change Project: Harnessing the power of artificial intelligence and machine learning for evidence synthesis and interpretation. *Implementation Science*, *12*(121).
- Phan, N., Dou, D., Piniewski, B., & Kil, D. (2016). A deep learning approach for human behavior prediction with explanations in health social networks: Social restricted Boltzmann machine (SRBM+). *Social Network Analysis and Mining*, *6*(1). doi:10.1007/s13278-016-0379-0