Part 1: Predictive Patterns of Behavior

1.1 Introduction

The concept of predictive patterns of behavior 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 behavior, and how this influences an individual's behavior dramatically.

1.2 Importance of Prediction of Human Behavioural Patterns

Modeling of human behavior 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 behavior can also predict the possibility of actions such as click, buy, or call. Prediction of human behavior 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 behavior do not throw light on the mental or physiological mechanisms that lead to these predictive behavior patterns in an individual (Phan et al., 2016).

1.3 Social Cognitive Theory and Predictive Behavioural Patterns

One explanation for predictive patterns of human behavior is that behaviour 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 behaviors in the context of social and environmental influences, but also enables the prediction of future behaviors 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 behavior, thereby making it predictable (Greve, 2015).

1.3.1 Hierarchical Predictive Coding and the Social Environment

The underlying mental processing that gives rise to predictive behavior patterns is overly 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 behavior of the individual. If significant differences are detected in earlier responses stored in the loops, all these responses are used in predicting the individual’s future behavior. 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).

1.4 Interactivity and Predictive Behavioural Patterns

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 behavior. It considers anticipation to be an essential

element of predictive behavior 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 behavior.

1.4.1 Synthesis of models that explain Interactivity

Predictive processing and prediction-based generative modeling have been dwelled upon extensively using the human brain as a model which generates predictive behavior patterns. Each individual brain has its own model of the world by using generative modeling, wherein the brain moves backward by analyzing 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 typification 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 based on 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 behavior patterns in an uncertain environment (Kelly et al., 2018).

1.5 Behaviour Change Interventions

Behavior Change Interventions (BCIs) have been developed to bring about significant changes in human behavior patterns. They may be in the form of policies, services, activities, or products designed to bring about dramatic changes in the predicted behaviors 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 behaviors that are targeted for change vary widely from reduction or elimination of negative behaviors to enhancing the incidence of positive behaviors in individuals. As a result, the specific interventions that bring about a change in predictive patterns of human behavior also need to be tailored based on the type of behavioral 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 behavior 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 behavioral risk factors such as smoking, promote protective behaviors such as health screening camps, promote adaptation to diagnosed health conditions through medication adherence, and alter healthcare workers' behaviors 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 behaviors. 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 considering observed usage and behavioral 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 behavioral interventions on predictive patterns of behavior (Ainsworth et al., 2017).

1.6 Conclusion

This paper covered the various theories and models that explain predictive patterns of human behavior 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 behavior change interventions for altering individual behaviors with potentially harmful effects. For instance, harmful health behaviors 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 behavioral 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.

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Part 2: Interactions that influence cognitive comprehension

2.1 Introduction

Cognitive psychology primarily aims to analyse and explain those mental processes that human beings use to understand and describe concepts in their environment. This can be achieved by understanding internal factors relating to thought processes in the mind, and external factors in the environment that promote cognitive comprehension, and the interactions of these internal and external factors. This part of the essay aims to draw inferences between the interactions between internal and external factors, and cognitive comprehension. It also aims to highlight the relationship between predictive behavioural patterns and social cognitive theory with cognitive comprehension.

2.2 Cognitive Comprehension

In its most basic sense, comprehension refers to the capability of the human mind to understand objects, concepts, and actions using the abilities of reasoning and abstract thinking. Cognition is fundamental to comprehension in that it allows the human mind to process knowledge and understanding using our intrinsic perceptive abilities. These abilities enable the human mind to draw on previous personal experiences and fundamental characteristics that allow us to analyse and interpret the various objects and actions taking place in our environment (Wang et al., 2003).

In the field of cognitive psychology, comprehension refers to the process of construction of an internal representation of knowledge and understanding on the basis of the information stored in the human brain. In this context, the various cognitive processes such as learning,

reasoning, attention, perception, decision-making, and language, and their interactions promote comprehension in the human mind by drawing on previously stored knowledge and experiences. The key point here is that cognitive comprehension varies for every individual as it is intricately connected to the prior experiences and knowledge the person has gained over his/her lifetime. Therefore, in order to understand a phenomenon or occurrence in the environment, every individual goes through different comprehension processes based on prior experiential contexts (Panayiota et al., 2014).

2.3 Social Cognitive Theory and Cognitive Comprehension

Several studies have focused on information processing and its influences on human behaviour in terms of specific mental processes in acquiring knowledge. Several social psychologists have proposed different theories regarding the processes involved in cognitive development and learning. One of the prominent psychologists, Bandura (1886) formulated the social cognitive learning theory according to which learning is a dynamic process and is fueled by the interactions between personal factors, environmental factors, and behavioural factors. According to this theory, imitation of a behaviour observed in another person is the consequence of interactions between intrinsic and extrinsic factors, and the individual's behavioural patterns (Aryadoust, 2017).

One of the most important intrinsic or individual factors that influence comprehension is an individual's belief in his/her abilities to demonstrate successful results. If a person's degree of self-worth is high, s/he will be able to inculcate behaviours that lead them to success and accomplishments. However, if this degree is low, the person will shy away from adopting those behaviours that can, in turn, increase their sense of self-worth. In contrast, behavioural factors

are a reflection of the behavioural responses of other individuals which gives people the impetus to perform well and promotes effective learning. According to Bandura (1886), social elements in a suitable environment are more helpful for promoting learning and comprehension as opposed to direct enforcement in an isolated environment. Social and environmental factors play a major role in bringing out certain types of behaviours in individuals and therefore, these factors have a widespread influence on learning and comprehension (Aryadoust, 2017).

The social cognitive theory provides a behavioural and emotional structure for the synthesis of processes and concepts that explain cognitive comprehension. It explains the interactions between a person's own learning experiences, and other people's behavioural responses and their consequences. Therefore, according to this theory, comprehension in a social context is the result of interactions between individual and observed behaviours, and perceptions of their specific consequences. Individuals often tend to remember and recollect a given sequence of actions and use this knowledge to inculcate certain behaviours that promote their comprehension in a social environment (Panayiota et al., 2014).

2.4 Predictive Patterns of Behaviour and Cognitive Comprehension

It has recently come to light and is a widely accepted fact that the human brain is not a passive organ, but is actively involved in the prediction of possible consequences and behavioural patterns in individuals. The predictive ability of the brain is empirical in promoting smooth cognitive functioning. This prediction has been found to play a role even in reading and learning comprehension activities. For example, people can often predict the next word in a sentence if sufficient context has been generated in the previous sentences (Willems et al., 2016).

In general, predictive processing is used to analyse past experiences and present situations, and provide a basis of assumption for future consequences. This is an important prerequisite for information processing, and depends on the interactions between motor control, cognitive control, perception, decision-making, mind theory, and other cognitive processes that take place in the human mind. Close interactions between motor and sensory processes in the human brain have been implicated to explain cognitive abilities, especially in terms of visual comprehension. These processes interact to promote accurate action selection in order to anticipate future outcomes (Bubic et al., 2010).

2.5 Interactions that Influence Cognitive Comprehension

Apart from the social cognitive theory and predictive patterns of behaviour, there are several other factors at play that influence cognitive comprehension. For instance, reading comprehension requires a close interaction between the reader, the text, and the action of reading to have successful consequences. There are several different theories that explain linguistic and cognitive characteristics in relation to reading. Some of the theories focus on the reading and learning skills that have been developed previously and their interactions with the environment. Some others talk about the reader's individual context on the basis of which s/he interprets the meaning of the text. In either case, several intrinsic and extrinsic factors interact to provide the basis of comprehension for the reader (Panayiota et al., 2014).

In any case of learning and reading, comprehension involves using prior knowledge and experience to interpret the environment. Generating interpretations from the environment involves forming relationships between background information and characteristic features of the processes taking place in the environment. Development of these skills begins early in a human

brain and increases both qualitatively and quantitatively upon gaining new experiences. As people grow in age and experience, they learn several things about their social environment, and slowly they start forming connections between what they observe and what they experience in their lives. Psychological experiments have demonstrated that children exposed to aggression since a young age turn out to be verbally and physically aggressive in their adult lives, having learnt from cues in their social environment. Apart from this, they also start developing and attaching abstract emotions to the activities taking place in their environment, and in so doing, they learn to make connections between things that help them predict events and emotions in the future (van den Broek and Espin, 2012).

The social environment forms just one part of the influential factors on a person's comprehensive abilities. The other part is contributed by the executive and functional skills of a person that promote understanding and regulate behaviour. One of these factors is the memory that plays a major role in information processing and correlation with current events. The ability of the human brain to maintain an active memory and interact with the immediate environment determines an individual's capability in storing and marking the information for future use. Information that is stored in the working memory is often used to interpret and evaluate activities that take place every day such as writing and reading, planning, solving problems, and communicating with each other. Differences in individual contexts and changes in memory processing act as the basis for differences in behavioural patterns in individuals. This memory is not only influenced by prior experiences, but also by age and genetics, thereby resulting in unique behavioural patterns in different individuals (Wahyono, 2019).

2.6 Conclusion

The social cognitive theory and its role in cognitive comprehension have been well-studied and form the basis of our understanding of the interactions between internal and external factors. Internal factors include those that define an individual such as childhood exposure, past experiences, education and financial contexts, and behavioural patterns of people in close contact with the individual. This remains constant, while external factors vary with the activity being done such as reading, learning, or communicating. A close interaction between one or more factors from each of these two groups contributes to unique comprehensive abilities in individuals and brings forth the differences in their thinking and learning capabilities. It also contributes to predictive behavioural patterns in individuals that draw on the information stored regarding every past experience in the human brain.

The study of these interactions has several applications, especially for individuals with comprehension and learning disabilities. Depending on childhood exposure and other factors, young children may be provided with visual media as learning materials to foster their creative thinking abilities. Additionally, as the social environment plays an important role in learning and comprehension, instructional learning should also encompass interactions with environmental factors, thus promoting learning at every level.

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