A Biological Analysis of the Difficulties in Replicating Human Subjective Experience in Artificial Systems

Yifei Xie

{yxie518@aucklanduni.ac.nz}

Faculty of Science, University of Auckland, Auckland Central, Auckland, 1010, New Zealand

Abstract. Current neuroscience research shows that emotion-, cognition-, and embodiment-related brain activities underlie human subjective experiences, including bodily awareness and immediate pleasure. However, despite rapid advances in artificial intelligence and brain-machine interface technologies, artificial systems still struggle to reproduce the embodied, emotional, and cognitive processes that contribute to human subjective experience. The paper discusses how biology explains subjective experience and why these processes are not easily recreated in artificial systems. The paper examines the biological mechanisms underlying subjective experience and the challenges involved in implementing comparable mechanisms in artificial systems.

Keywords: Subjective experience; emotion; artificial intelligence

1 Introduction

Human subjective experience, which encompasses strong emotions, bodily feelings, and instant pleasure, forms one of the main aspects of daily life. Individuals do not just react to the world in a rational manner, but also react with excitement, stress, discomfort, or other feelings. Such experiences have been commonly termed as very personal and strongly related to bodily reactions. Over the past few years, neuroscience has achieved necessary developments in the explanation of how these experiences are backed by brain activity, mainly through research on emotion, reward, and physical perception [1,2]. Nonetheless, despite all these improvements, subjective experience continues to be hard to describe fully, and more problematic to synthesize beyond the biological systems.

Meanwhile, artificial systems like brain-machine interfaces and Artificial Intelligence have developed rapidly. Modern AI systems can learn from data, make decisions, and even replicate human behaviour in complicated duties. Specifically, brain-machine interfaces have the ability to read neural signals and permit computers to directly communicate with the brain. In spite of these

ICIAAI 2026, May 22-24, Singapore, Singapore

DOI 10.4108/eai.22-5-2026.2365135

accomplishments, artificial systems do not possess anything that is fundamental to human beings: they do not seem to possess feelings. Although an AI system can be conditioned to produce maximum rewards or prevent punishment, this process is highly contrasted with the one human beings feel pleasure, motivation, or emotional significance [3]. This gap poses a very significant question as to whether or not subjective experience is actually recreatable by artificial systems.

Previous research has addressed the issue from several directions. A significant point of departure is neuroscience, which is concerned with the neural processes of emotion and reward. Research in this field demonstrates that emotional and reward-related mechanisms are highly distributed throughout the brain and highly connected to the state of the body [1,4]. The second direction in cognitive science is where scientists focus. Cognition and subjective experience are a result of constant interaction of the brain, body, and the environment [5,6]. A third approach is inspired by artificial intelligence research that tends to treat the problems of learning and reward as computational problems. In this model, the externally defined values are optimized using algorithms instead of being experienced internally. Though both of these approaches have helped to gain valuable insights, put together, they also demonstrate the underlying differences between the biological and artificial systems.

The paper aims to discuss the mechanisms behind the explanation of subjective experience by the biological process and why these mechanisms are hard to replicate in artificial systems. First, the biological foundations of subjective experience, such as embodiment, emotion, and immediate pleasure, will be presented. The paper will discuss why artificial systems struggle to replicate these features. Lastly, the future research implications in neuroscience and artificial intelligence will be considered.

2 Embodiment, Emotion, and Reward in Human Subjective Experience

The brain does not produce subjective experience alone but interacts with the body. The embodiment of cognition and experience is one of the significant concepts in neuroscience. This implies that physical states, including heart rate, breathing, and internal sensations, under a continuous condition, determine the ways people perceive and feel the world [1]. Anxiety, as an example, is not only a state of mind, but also a visible physical alteration of the body. The brain incorporates these signs in the conscious experience [1,7]

Emotion plays significantly affects the subjective experience. Emotions affect attention, judgments, and perception rather than being distinct from thinking. Evidence indicates that a variety of brain areas collaborate in emotional processing, and these areas encompass memory, reward, and sensory processing areas [2]. Constructionist perceptions of emotion suggest that the brain constructs emotional experiences to include bodily sensations, past experiences, and the context of the situation [4]. This is one of the reasons why the same situation may seem very different to different individuals, or even to the same person at other occasions.

The brain's reward system is closely connected with immediate pleasure, like the pleasure that one may experience from food, music, or movement. Dopamine systems are very crucial in the process of reward anticipation and incentive, and yet the very sensation of pleasure is not a mere chemical reaction. Rather, it relies on anticipations, mood, and physical health [8]. It is important to note that these reward processes cannot be static and remain constant in time as an individual learns and varies. Combined, embodiment, emotion, and reward are complex biological system, which reinforces human subjective experience. This system is broadly context-dependent, flexible, and entrenched within the physical body, which makes it a fundamentally different system compared to the current artificial systems.

3 Neural and Embodied Mechanisms of Subjective Experience

Biologically based, subjective experience is not generated by either a single part of the brain or a simple neuro signal. Rather, it emerges from the interaction of various neural systems that process sensation, emotion, memory, and body states at the same time. Research in neuroscience has indicated that conscious experience is reliant on distributed brain processes and not on an isolated "centre of experience" [7-9]. It implies that the feeling of pleasure or emotion presents a concerted activity of numerous brain regions.

The body's role in the shaping of experience is one of the necessities. The body sends signals to the brain continuously, through heart rate, muscle tension, and internal sensations, and this determines the way in which situations are perceived. Particularly, body cues play an important role in shaping emotions and conscious cognitions [1]. In the case of pleasure, it is also a physical sensation that is directly related to physical responses and not a mental judgment that something is enjoyable. This deep relation of the body with the brain enables experience to be vivid, immediate, and personal.

Emotional and reward systems shape subjective experience by assigning value and meaning to events. The brain predicts rewards and guides behaviour with dopamine-related pathways, which are not the only things that make pleasure itself. It is found that pleasure depends on contexts, expectations, and past experiences [8]. Due to this fact, a certain stimulus may create different experiences in the case of varying emotional states or the history of a person. Such characteristics render human subjective experience adaptive and flexible, yet also complicated and not simple to simplify into simple rules.

Overall, subjective experience may be described on the neural level as a dynamic and predictive process that incorporates the inputs of the human body, emotional appraisal, and the expectations acquired in the previous courses [10]. This is an ongoing process in which the person is constantly updated as the individual interacts with the environment. Notably, it is firmly ingrained in the biological systems that have evolved in order to make survival and adaptation possible.

4 Limits of Artificial Intelligence in Reproducing Human Experience

Although artificial systems can simulate some of the elements of human behaviour, they find it difficult to reproduce the subjective experience. The absence of embodiment is one of the causes. AI systems lack the biological forms of artificial intelligence that generate the internal sensations of pain, hunger, or fatigue. Although sensors have the ability to give information about the outside world, they do not eliminate the intricate internal cues that define human experience [5]. It is impossible to have artificial systems that form experiences in the same integrated manner as people do without these bodily signals.

The other significant weakness is the definition of reward in artificial systems. Reward and emotion affect nearly everything in the human mind, perception, and attention. The emotional states have the ability to alter the way the brain builds information at its most fundamental level . On the contrary, artificial systems tend to depend on externally specified reward functions that are human-designed. To illustrate, reinforcement learning systems are trying to maximize numerical rewards, which do not have a personal meaning or emotions associated with the system itself [11]. Consequently, the system is able to maximize behaviour without pleasure and motivation.

Artificial systems lack personal history and subjective continuity. Human experience is determined by a life history that is irrevocable and inimitable. The past experiences contribute to the current feelings and anticipations, forming a special subjective view. However, artificial systems can be copied, restarted, or trained repeatedly with no feeling of loss or continuity. Such disparity renders the attempt by artificial systems to come up with a consistent, individualistic perspective of the world hard to achieve, and that is similar to the human subjective experience. Lastly, subjective experience is always a first-person experience [12]. Though the activity of the brain can be gauged and behaviour can be observed, the experience cannot be accessed directly by anybody. Artificial systems are capable of generating outputs that have similarities to human responses.This begs the question of whether the subjective experience has to be constrained by the biological factors that artificial systems are not [7]. Overall, these constraints indicate that existing artificial systems can alleviate features of human behaviour, but not subjective experience

5. Future direction

Although current artificial systems have some difficulties in reproducing the human subjective experience, future research might help reduce the gap. The development of more embodied artificial systems may be one of these directions. It has been proposed that more human-like cognition can be achieved by providing artificial agents with more bodily interactions with the environment[8]. Moving, sensing, and continually interacting with the environment, robots can have more complex ways of learning and adapting than purely digital systems. Other fields considered include affective computing, which tries to simulate and react to the emotions of humans. These systems can seem more emotionally intelligent by letting them identify emotional signals and change their behaviour in accordance with these signals. Although an artificial system might be able to place the emotional

states in the right positions, it remains uncertain whether this translates to true subjective experience or just the behavioural imitation is improved [10].

New insights can also be achieved by advances in brain-machine interfaces. It can be directly connected to the neural activity, and thus, the researchers can understand how the subjective experience is reflected in the brain much better. Nevertheless, the brain machine interfaces are now concerned with decoding instead of experience per se reconstruction. This indicates that artificial systems might not be able to create subjective experience without having such technical improvements.

Overall, future research results in a significant open question: is it something subjective, which can be produced by any sufficiently complex system, or does it have biological limitations that are not available to artificial systems? Addressing this question will require collaboration between neuroscience, cognitive science, and artificial intelligence.

6 Conclusion

This paper examined how biology explains human subjective experience and why such processes are difficult to reproduce in artificial systems. Through reviewing research from neuroscience and cognitive science, the paper revealed that subjective experience relies on the synthesis of body signals, emotion processing, and reward systems. These processes are dynamic and continuous, and they help in determining the way humans feel pleasure, emotion, and meaning.

The comparison also revealed some major differences between biological systems and artificial systems. Though artificial intelligence can recreate behaviour and maximise its rewards, it does not truly embody it, nor does it modulate emotions or have continuity. The rewards of the artificial systems are externally determined and without meaning. Human experience is influenced by a personal past and the continuous connection between the human brain and the body.

Such findings indicate that current artificial systems have difficulty in reproducing subjective experience. Even though the gap can be reduced in the future with technologies like embodied AI and brain-machine interface, there are still structural differences. These differences may be of importance not only in the enhancement of artificial systems, but also in understanding what makes human experience special. This point may guide future studies in neuroscience and artificial intelligence.

Reference

[1] Damasio, A.R.: The Feeling of What Happens: Body and Emotion in the Making of Consciousness. Harcourt Brace (1999)

[2] Pessoa, L.: On the relationship between emotion and cognition. Nature Reviews Neuroscience. 9(2), 148–158 (2008)

[3] Sutton, R.S., Barto, A.G.: Reinforcement Learning: An Introduction, 2nd edn. MIT Press (2018)
[4] Barrett, L.F.: How Emotions Are Made: The Secret Life of the Brain. Houghton Mifflin Harcourt (2017)
[5] Clark, A.: An embodied cognitive science? Trends in Cognitive Sciences. 3(9), 345–351 (1999)
[6] Varela, F.J., Thompson, E., Rosch, E.: The Embodied Mind: Cognitive Science and Human Experience. MIT Press (1991)
[7] Seth, A.K.: Interoceptive inference, emotion, and the embodied self. Trends in Cognitive Sciences. 17(11), 565–573 (2013)
[8] Berridge, K.C., Kringelbach, M.L.: Pleasure systems in the brain. Neuron. 86(3), 646–664 (2015)
[9] Dehaene, S.: Consciousness and the Brain: Deciphering How the Brain Codes Our Thoughts. Viking (2014)
[10] Friston, K.: The free-energy principle: A unified brain theory? Nature Reviews Neuroscience. 11(2), 127–138 (2010)
[11] Tononi, G.: An information integration theory of consciousness. BMC Neuroscience. 5(1), Article 42 (2004)
[12] Nagel, T.: What is it like to be a bat? The Philosophical Review. 83(4), 435–450 (1974)