Yes/No/NG Questions Strategy Practice

What Is Dopamine - And Is It to Blame for Our Addictions?

The key difference between human brains and those of other animals is the size and complexity of our cerebral cortex, the brain's outer layer of neural tissue. We therefore tend to focus our attention on this area, believing that our unique mental life is due to this masterpiece of evolution. However, we often ignore the bits that are nearly identical between humans and animals, such as the tiny group of brain cells that use the chemical dopamine to communicate with other brain cells. Dopamine is often described as the brain's "pleasure chemical", but it is actually involved in a large number of physical and mental processes. It is used by a cluster of neurons in the midbrain to transmit messages to other neurons. The dopamine neurons are small in number (~0.0006% of the neurons in the human brain) and they are observed in all mammals and even "simple" animals such as turtles.

In the 1950s, researchers discovered that rats appeared to enjoy the stimulation of the nerve bundle that links the dopamine neurons with their targets in the forebrain. The rats would learn to press a lever for this kind of stimulation, and, left unchecked, would do so thousands of times in a day. A similar (and wholly unethical) experiment was performed in 1970 on a human patient. Like the rats, the patient learned to press a button to stimulate the dopamine nerve bundle, pressing the button up to 1500 times over the course of a three-hour session and reporting feelings of pleasure during the stimulation.

Since then, studies have shown that the dopamine system can be activated by a wide range of pleasant experiences, such as eating, sexual intercourse, getting revenge, winning video games, listening to music, earning money and reading funny cartoons. The dopamine system also responds robustly to addictive drugs, including opiates, alcohol and cocaine. These drugs can evoke stronger activation than natural rewards and, unlike natural rewards, they do not cause satiety. A straightforward interpretation of these facts is that the dopamine system is a pleasure pathway in the brain. This potentially explains why animals and people would be willing to press buttons or push levers to activate the dopamine neurons. It might also explain why some drugs are so addictive. The strong and prolonged activation induced by drugs can act as a "super-reward", making drugs even more desirable.

However, many mental events occur near the time of a reward, including changes in motivation, arousal, attention, emotion, and learning. For example, imagine passing by a vending machine that offers sweets. If you are motivated by hunger, your attention will be drawn to the machine and you will become more alert as you approach it. Once you have eaten the sweets, you experience pleasure, your brain learns to associate the vending machine with reward, and your hunger decreases. It is likely that the dopamine system is involved in many of these processes rather than just pleasure per se.

One of the most important aspects of dopamine function is learning. Researchers believe that dopamine neurons change their activity when expectations about reward do not match the reality, signalling a 'reward prediction error' that drives learning. For instance, dopamine neurons are activated by unanticipated rewards, but they are suppressed when expected rewards fail to materialise. Events followed by increases in dopamine activation become associated with reward, and those that are followed by decreases are linked with disappointment. If the environment is unchanging, all our brains need to do to obtain reward is to engage in actions that activate the dopamine neurons and avoid the ones that suppress them.

It is highly unlikely that we have much awareness of the learning that dopamine activation induces, such as making us attached to things we unknowingly associate with dopamine activation. This lack of awareness might explain why people often make seemingly irrational or maladaptive choices. Imagine a drug addict taking cocaine. Because the pleasure from cocaine does not satiate like a natural reward, the dopamine activation, and hence drug-induced learning, occurs with each puff of the crack pipe, making the actual pipe an object which the addict is drawn to.

Can brain research be used to overcome the effects of dopamine in addiction? Neuroscientists are actively pursuing the creation of drugs that block the learning induced by dopamine in addiction. However, they have had limited success, for it is difficult to create a drug that blocks the learning without also blocking other functions of dopamine, such as feeling alert, motivated and happy. Dopamine-induced learning is certainly not the whole story behind addiction, but it does suggest that we should consider whether addiction is something that human reasoning on its own can overcome. The same might very well also apply to other everyday failures of willpower, such as overeating. Our special cerebral cortex may be in control of our actions, but our primitive dopamine system may very well serve as its teacher.

Questions 1-10

Do the following statements agree with the claims of the writer in the passage?
Yes *if the statement agrees with the claims of the writer*
No *if the statement contradicts the claims of the writer*
Not Given *if it is impossible to say what the writer thinks about this*

1. There are many ways in which human brains differ from the brains of other animals.

2. The cells in the brain that make use of dopamine as a means of communication are unique to humans.

3. Dopamine can be characterised in other ways than as simply a chemical involved in the sensation of pleasure.

4. The experiment carried out on a human subject in 1970 was unethical because it lasted for 3 hours.

5. A possible explanation for the addictiveness of some drugs is that they cause a big stimulation of the dopamine neurons and this leads to a big feeling of pleasure.

6. People who are hungry are more affected by the feeling of alertness than the feeling of pleasure.

7. The more an expectation of being rewarded is not met, the more the dopamine neurons in the brain are activated.

8. Most people are probably very conscious of the process of learning that is brought about by means of dopamine in the brain.

9. Someone who is addicted to cocaine may well be attracted to the physical pipe they use to smoke the substance as well as to the substance itself.

10. A problem which arises for scientists working on dopamine is that it is easier to create a drug that blocks the happiness function of dopamine than one that blocks the learning function.