Physical and Physiological Aspects of Drug Use and Abuse

Question 1: What are neurons and neurotransmitters?

Answer 1: A neuron is a nerve cell. It is estimated that there are 100 billion neurons in the average human brain (Levinthal, 2008). Neurons receive and transmit information to each other in order to allow the brain (and body) to function properly (Butcher, Minkeka, & Hooley, 2007). Neurons are often divided into three principal components: the cell body, the dendrite, and the axon. The cell body contains the nucleus and makes up the bulk of the neuron (Levinthal, 2008). Dendrites extend from the cell body and receive incoming information from other cells. An axon also extends from the cell body and transmits information to other cells (Levinthal, 2008). At the end of the axon, there are branches that have small, round structures called synaptic knobs. Neurotransmitters are contained within synaptic vesicles inside each synaptic knob. Synapses are the gaps between neurons. Neurons communicate using nerve impulses, which are electrical charges that travel down the axon of one neuron and then are transmitted across the synapse to the next neuron through the action of neurotransmitters (Levinthal, 2008).

Neurotransmitters act as messengers traveling across the gap between neurons to transmit messages. Synaptic vesicles, which are located at the end of axons, produce and store millions of neurotransmitters (Levinthal, 2008). When a nerve impulse reaches the synaptic knob at the end of the axon, neurotransmitters are released into the synapse (Butcher et al., 2007). These neurotransmitters fit into special receptor sites located on the next neuron like a key fitting into a lock. Once the neurotransmitter fits into the receptor site, an electrical charge is released into the receiving neuron transmitting the nerve impulse (Levinthal, 2008). After the neurotransmitter has released its electrical charge, it usually is released from the receptor site and travels back to the synaptic knob. This process of returning to the synaptic vesicles is referred to as reuptake (Levinthal, 2008).

Over 50 different types of neurotransmitters have been studied (Levinthal, 2008), but there are seven in particular that have importance in the study of the effects of psychoactive drugs. Those seven include the following (Levinthal, 2008):

- **Acetylcholine:** One type of receptor for this neurotransmitter is responsive to nicotine
- **Norepinephrine:** Involved in the regulation of mood
- **Dopamine:** Affects motor control, emotionality, and cravings
- **Serotonin:** Regulates mood
- **Gamma aminobutyric acid (GABA):** Affects feelings of anxiety
- **Glutamate:** Seems connected to abuse potential of hallucinogens and
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drug cravings
- **Endorphins:** Natural painkillers in the brain

It is thought that drugs work at the level of neurons by changing the way that neurotransmitters are released and binding to receptor sites (Levinthal, 2008).

**Question 2:** How is the Drug Abuse Warning Network used to compile information on drug abuse trends?

**Answer 2:** The Drug Abuse Warning Network (DAWN) is a program through which the U.S. government gathers information concerning drug-related medical emergencies in hospitals in major metropolitan areas (Levinthal, 2008). The hospitals report the number of times that a person visits the hospital emergency room for any reason that is connected to drug use and the number of drug-related deaths that occur at the hospital. The hospitals report a range of information connected to the incidents, such as the type of drug and the age and gender of the patient (Levinthal, 2008). These statistics allow the government to estimate trends in the types of drugs being abused and geographical distribution, among other things. The information comes from large metropolitan areas, so care must be taken to consider rural trends in drug abuse as well. For example, methamphetamine abuse is a larger public health concern in rural areas than it might be in many metropolitan areas (Levinthal, 2008).

**Question 3:** What are the roles of risk factors and protective factors in predicting drug use?

**Answer 3:** To formulate drug-abuse prevention efforts, it can be useful to have some idea about which individuals, particularly adolescents, are more likely to engage in drug use. Risk factors and protective factors are characteristics or behaviors that have been found to have some relation to the likelihood that a person will use drugs. Risk factors indicate that a person is more likely to become involved in drug-taking behavior, and protective factors are associated with a decreased likelihood that a person will become involved with drugs (Levinthal, 2008). The presence or absence of these factors in a particular person cannot be used to predict entirely whether that person will engage in drug use; however, the presence of risk or protective factors can indicate the degree of vulnerability a person might have to drug-taking behaviors. Protective factors are thought to provide a basis for someone to have more resistance against the temptation to take drugs or engage in a drug-taking lifestyle. Examples of protective factors are parental involvement, positive educational experiences, and generally positive attitudes and beliefs.
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(Levinthal, 2008). Risk factors include poor family relationships, risk-taking behaviors, and negative peer influence (Levinthal, 2008).

**Question 4:** What is meant by the reward circuitry or pleasure centers of the brain?

**Answer 4:** Systems within the brain that produce feelings of reward or satisfaction are sometimes referred to as the reward circuitry or pleasure centers of the brain. There are different neurotransmitters in the brain that are involved in producing feelings of reward or satisfaction. Dopamine has been the most widely studied neurotransmitter in terms of reward circuitry, and some of the reward pathways and systems within the brain are referred to in terms of being a part of the dopamine system in the brain (Howell, 2004). Gamma aminobutyric acid (GABA) also plays a role in triggering feelings of reward by sending information to the dopamine system. It is thought that many psychoactive drugs create a short-term surge in dopamine and other neurotransmitters that signal pleasure or reward (Helmuth, 2001). This stimulation of the pleasure or reward systems of the brain is thought to play a role in the development of addictive behaviors relating to psychoactive drugs.

**Question 5:** What is drug tolerance?

**Answer 5:** According to the American Psychiatric Association’s Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR), fourth edition, text revision (2000), tolerance is the need for increased amounts of a substance to achieve the desired effect of the substance. The same amount of the substance produces less and less of the desired effect. Physiological tolerance refers to a type of tolerance that comes about when the body makes adjustments to compensate for the effects of the continued use of a drug (McKim, 2003). Feedback loops control many of the physiological processes, similar to a thermostat (McKim, 2003). When the temperature in a building goes below a certain set temperature, the thermostat activates the heating system. Similarly, when the normal functions of the body are disturbed, many times the body will make adjustments to counter that disturbance. If a drug is used repeatedly, the body becomes better at adjusting to the drug's effects and returning the bodily processes to normal function (McKim, 2003).

**Question 6:** What factors influence the effect of a drug?

**Answer 6:** Many factors affect the physiological impact of a psychoactive drug. The method of delivering the drug into the bloodstream, such as inhalation, injection, absorption, or oral administration, will affect how the drug affects the
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body (Levinthal, 2008). For example, some drugs produce more effect if injected rather than swallowed. If a drug has been administered repeatedly, then tolerance to the drug may develop, and the drug will have less effect (McKim, 2005). If multiple drugs are administered, then the interaction might affect the resulting changes produced in the brain (Levinthal, 2008). The timing of the administration of the drug can produce different results if the drug is administered repeatedly (Levinthal, 2008). In addition, the development of tolerance to Drug A over time might then mean that a person develops a tolerance to Drug B as well because of similarities between the drugs; this is a phenomenon called cross-tolerance (Levinthal, 2008). Individual differences also contribute to a drug's effects. Two people who have taken the exact same drug may have different reactions due to characteristics of the individuals (Levinthal, 2008).

**Question 7:** What is the disease model of addiction?

**Answer 7:** For a long time, it was thought that people who became addicted to alcohol or drugs did so simply because they had poor morals or poor self-control. In the late 1800s, however, the most widely abused drugs were the medications morphine and laudanum, which were derivatives of opium (McKim, 2003). Society then began to think of substance abuse as being, like medication, under the authority of doctors. A reform movement arose that advocated thinking of addiction as a disease rather than a moral issue (McKim, 2003). The disease model has fallen in and out of favor over the years. The disease model shifts blame for the addiction away from the person who is abusing the drugs by depicting addiction as more of a sickness; however, one problem with the disease model is that it is difficult to show that substance abuse truly works like a disease such as the flu or diabetes.

**Question 8:** What is positive reinforcement?

**Answer 8:** Positive reinforcement refers to any stimulus that prompts the person receiving the stimulus to increase the behavior that gave them the stimulus (McKim, 2003). If a child finds he receives a cookie every time he smiles, that child might keep smiling repeatedly so that he can receive that cookie; it is a positive reinforcer. In many cases, positive reinforcement refers to stimulus that gives pleasure, but it does not have to be pleasurable. In certain circumstances, an electric shock can be used for positive reinforcement (McKim, 2003). Some theories of addiction rely on positive reinforcement models. This kind of model assumes that people use drugs because the drugs act as positive reinforcers (McKim, 2003). One experiment that illustrates this principle was conducted by Pickens and Thomson and published in 1968. Rats were implanted with a means for receiving cocaine directly into their jugular
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vein. The rats were then placed in a small chamber with food and water. There were also two levers in the chamber. If the rat pulled one lever, then it received a small amount of cocaine; if it pulled the other lever, nothing happened. After a few days, the rats were pulling on the cocaine lever at a rate of about 8 to 12 infusions per hour. When the situation was changed so that the rats only received an infusion of salt water instead of cocaine, the rats stopped pulling on that lever (McKim, 2003).

Some criticisms of the positive reinforcement models of addiction point out that addicts often have just as many if not more negative consequences of their drug use as positive ones. The positive reinforcement model has trouble explaining why people keep using drugs despite increasingly negative consequences (McKim, 2003).

Question 9: What is substance withdrawal?

Answer 9: The American Psychiatric Association’s Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR), fourth edition, text revision (2000) describes substance withdrawal as “maladaptive behavioral change, with physiological and cognitive” components that comes about when a person reduces or stops a long-term, heavy pattern of drug use. Symptoms may be considered physical, such as sweating or tremors, or more psychological, such as anxiety or fatigue. Specific withdrawal symptoms as well as their pattern and duration will vary according to which drug or drugs the person has been using. These withdrawal symptoms may cause significant impairment or distress for the person who is quitting substance abuse (APA, 2000). Withdrawal from heavy use of caffeine can occur within 12 to 24 hours of the last intake and last for as long as a week, causing headaches, fatigue, and moodiness (McKim, 2003). Depression is considered one of the most prominent symptoms of withdrawal from cocaine or other psychomotor stimulants (McKim, 2003).

Question 10: What is a placebo?

Answer 10: A placebo is an inactive substance with no treatment value. In experiments conducted to find out the effects of a drug, scientists need to be able to compare a test group that is taking the psychoactive drug to a control group that is taking an inactive pill (Levinthal, 2008). In these experiments, a placebo is an inactive substance with no pharmacological effect given to the control group. The reason that a placebo is needed is that sometimes the expectation of how a pill will work is enough to create a physical or psychological effect. For example, a person who has snorted a line of sugar
that they believe to be cocaine may report feeling the effects of cocaine even though they have only been administered sugar. The placebo effect demonstrates how expectations can play a large part in the effects of a drug.

References


