Theories and a biopsychology of addiction

The biopsychology of addiction examines the interaction of biological aspects associated with addictive behaviors. The word “ addiction” comes from the Latin verb “ addicere” meaning to enslave (Yucel, Lubman, Solowij, & Brewer, 2007). The Diagnostic and Statistical Manual, Fourth Edition-Text Revision identifies drug addiction as a dependence syndrome with essential features of a lack of control over drug use despite significant drug-related problems (Kranzler & Li, 2008).

The prevalence and problems associated with drug addiction cost an estimated $524 billion a year, including health care, productivity loss, crime, incarceration, and drug enforcement (NIDA, 2009). Advanced research confirms that addiction is a disease because it alters the brain. It shares common attributes with other chronic diseases, such as heart disease and diabetes. The underlying concept is that there is a disruption in healthy functioning that results in serious, harmful consequences, although treatable, that can potentially last a lifetime (NIDA, 2009). Recreational drug use usually begins in adolescents at a stage in development most vulnerable to executive functioning impairment. Executive functioning impacts decision making, judgments, and emotional regulation. Brown, et al. (2008) found an increase in drinking during the age span between 16 to 20 years that fuels neurological damage and social impairments. Beckson (2005) reported an increase in adolescent drug use. Prevention of drug addiction needs to start during adolescents because it usually begins during this stage in development.

The goal of this paper is to explore multiple factors related to the biopsychology of addiction, including the molecular level of synaptic neuron

communication, neurotransmitters, brain anatomy, drugs of abuse, relapse, and long-term effects of addiction. The genetic and environmental influences along with stress play significant roles in drug addiction.

Theories of addiction exist with a growing agreement among experts that the Incentive Sensitization Theory of Addiction provides the best explanation. Robinson and Berridge (2003) describe several theories.

Opponent Process Theory of Addiction

The first theory described by Robinson and Berridge (2003), is the Opponent Process Theory of Addiction representing the traditional view of addiction. Pinel (2009) refers to this theory as the Physical-dependence Theories of Addiction. Initially drugs are taken for the positive feelings, but gradually build tolerance and dependence to the drug. Withdrawal symptoms begin and compulsive drug cravings take over. Drug use continues in an effort to avoid negative withdrawal symptoms and achieve the pleasurable effects again. Other names for this traditional theory of addiction include “ pleasure-pain, positive-negative reinforcement, opponent process, hedonic homeostasis, hedonic dysregulation, and reward allostasis (Robinson & Berridge, 2003). Limitations exist with this theory because not all drugs, such as heroin, produce serious withdrawal symptoms. A major argument against this theory is that after a period of abstinence the rate of relapse remains high despite the lack of withdrawal symptoms.

Positive-incentive Theory of Addiction

Another theory described by Robinson and Berridge (2003) involves aberrant learning suggesting that drugs create a strong connection to natural reward

centers based on learning through classical conditioning. Pinel (2009) refers to this theory as the Positive-incentive theories of drug addiction. Explicit learning as a subcategory of aberrant learning describes the learning process through declarative associations at a conscious level between actions and outcome. Explicit learning also involves the declarative predictive relationships between environmental cues and expectation or anticipation of rewards, such as drugs. Declarative learning does not sufficiently explain the transition from recreational drug use to drug addiction. Addicts do not report exaggerated declarative memories or expectations of drug pleasure because they know the pleasure gained is not worth the consequences suffered (Robinson and Berridge, 2003).

Implicit learning as a second subcategory of aberrant learning describes the unconscious procedural learning that occurs automatically by pairing a stimulus and response. Drug use becomes an automatic response through the “ corticostriatal loops operating through the dorsal striatum” (Robinson & Berridge, 2003). The aberrant learning theory does not hold up under scrutiny either because implicit learning does not actually generate an automatic response, such as tying your shoe, because it is compulsion that motivates the continuation of drug use and drives the cycle of addiction.

Incentive Sensitization Theory of Addiction

The Incentive Sensitization Theory of Addiction best explains the transition from drug use to drug addiction. According to Robinson and Berridge (2008), the theory states that repeated drug use changes brain cells and brain neural circuitry creating a hypersensitivity to repeated drug use and associated drug cues. Incentive sensitization generates a pathological

motivation or wanting of drugs that last for years, even after abstinence. The wanting of drugs may be implicit by an unconscious wanting or explicit by a conscious craving. The addict’s focus on drugs is created from an interaction between incentive salience mechanisms with associated learning mechanisms. Pathological motivation generated from sensitization of brain circuits stems from a Pavlovian conditioned incentive or motivational process, known as incentive sensitization. Associative learning can trigger the motivation for drugs through incentive attributes, such as within the context of associated drug experiences and interactions. The pathological motivation drives the addict to seek and obtain drugs at any cost. However, the stimulus-response learned association does not fully explain the core problem of addiction.

Damage or dysfunction in cortical regions creates changes in executive functioning resulting in impairments. These impairments play an important role in the addict’s poor choices about drugs coupled with pathological incentive motivation for drugs triggered through incentive sensitization. Sensitization specifically refers to the increase in drug effect caused by repeated drug use. Incentive sensitization is essence of the theory. Engagement of brain incentive or reward systems, include the mesotelencephalic dopamine systems. It is the hypersensitivity in the motivation circuitry that contributes mostly to the addictive wanting of drugs.

Evidence in favor of the incentive sensitization from past studies includes three features of incentive stimulus: Pavlovian conditioned approach to behavior, Pavlovian instrumental transfers, and conditioned reinforcement.

The sensitization related changes in the brain are important for the transition from casual to compulsive drug use. Changes in the brain include a much larger increase in the density of dendritic spines on medium spiny neurons in the core of the nucleus accumbens. It relates to development of psychomotor sensitization. Studies further indicate that the neural changes underlying sensitization may be sufficient to promote subsequent addict-like behaviors. The essential factor in addiction is neural sensitization.

Nature versus Nurture

On the one hand, a genetic predisposition toward drug addiction appears evident for a substantial number of individuals. Researchers are continuing to identify specific genes related to drug addiction. The use of Quantitative Trait Locus Mapping contributes to identify specific genes for the risk and protection against addictive behavior (Crabbe, 2002).

On the other hand, the learning hypothesis suggest drugs promote the learning of strong stimulus-response habits leading to compulsive behavior paired with rituals involved in consuming drugs (Robinson & Berridge, 2008). Associative learning occurs in drug addiction through Pavlovian conditioning. The motivation for drugs becomes incentive sensitive when encountering familiar associations within the context and surrounding of the drug use, friends, location, and the like.

Churchland (2004) argues that everything we know is the result of both our genetic makeup and our environmental experiences. Science has shown that development depends upon both genes and experience. Genes produce the “ hardware” and experience provides the “ software”. Learning occurs

through genetic unfolding that generates changes in cells through memory systems of learning experiences constructed from environmental experiences. Our brain neuromodulators act upon synapses and become strengthened with repeated exposure that provides the foundation for learning.

According to Kranzler and Li (2008) drug addiction stems from a combination of genetic, environmental, social, and psychological factors. The study of addiction involves multiple disciplines, including neuroscience, epidemiology, genetics, molecular biology, pharmacology, psychology, psychiatry, and sociology. It is not a matter of nature versus nurture, but more accurately nature and nurture.

It is well known that addiction stems from a genetic predisposition and environmental stress and influences. Li, Mao, and Wei (2008) report that an estimated 40% to 60% of genetic factors appear responsible for drug addiction and the remaining percentage of factors relate to environmental factors. Genes and common pathways appear to underlie drug addictions. In a study conducted by Li, Mao, and Wei (2008), an extensive review of the genetic research associated with drug addiction resulted in the creation of the “ Knowledgebase of Addiction-Related Genes (KARG)”. The KARG is the first database of a bioinformatic compilation of genetic research on addiction. Through statistical analysis of the database, the authors found five common pathways in addiction, including neuroactive ligand-receptor interaction, long-term potentiation, GnRH signaling pathway, MAPK signaling pathway, and Gap junctions. Advances in science from the use of new technology, such as tillingarray and proteomics, provide new avenues in

studying the underlying pathways and genetic composition of addiction and how addiction forms from environmental influences.

Brain Communication

Chemical messengers called neurotransmitters carry information across tiny spaces, called synapses that exist between neurons (Cruz, Bajo, Schweitzer, & Roberts, 2008). The brain communicates through electrical and chemical signals transmitted from neuron to neuron. A neuron represents the brain's communication network. A neurotransmitter is released from one neuron into the synapse within 20 to 50 nanometers of the receiving neuron (Lovinger, 2008). The releasing neuron is referred to as " presynaptic neuron" and has at the tip of its axon terminals small pockets known as " vesicles". These vesicles contain neurotransmitters that release molecules when activated by the action potential stimulated by the presynaptic neuron. The neurotransmitter is released into the synaptic gap between the two neurons. The post-synaptic neuron receives the neurotransmitter and binds it to the receptor site.

According to Lovinger (2008) two major categories of neurotransmitter receptors, include the ligand-gated ion channel (LGIC) receptors and G-protein-coupled receptors (GPCR). The LGIC produces an excitatory or an inhibitory reaction depending on the action potential. The GPCRs represent proteins that bind neurotransmitter molecules and activate intercellular reactions. Once the neurotransmitter is released it becomes rapidly removed by neurotransmitter transporters. The neurotransmitter transporters are housed on the surface of the neuron's cell membrane and rapidly retrieve

the neurotransmitter pulling it inside the neuron. The uptake reloads the neurotransmitter into vesicles and the cycle repeats.

Other brain chemicals exist, such as neurotrophins and steroid hormones. Lovington (2008) describes neurotrophins as peptides or amino acids secreted from different neuron structures, such as axon terminals and dendrites. Neurotrophins support neurons and assist in synaptic plasticity and neuron survival. Many are located within the central nervous system and the neural mechanisms that contribute to addiction (Lovinger, 2008). Steroid hormones represent small molecules that assist with intercellular communication. These hormones are found throughout the central nervous system as well.

Lovinger (2008) further describes “ agonist” as molecules that bind to and activate receptors. Antagonists also bind to neurotransmitter receptor sites by competing and blocking receptor activation. Many molecules serve as neurotransmitters, such as the amino acids, glutamate, and glycine. Histamines and different peptides also act as neurotransmitters. Neurotransmitters play a significant role in addiction.

Neurotransmitters

Fitzell (2007) defines neurotransmitters as molecules in the brain that transmit chemical reactions in order for neural communication to occur. There are approximately 100 billons neurons in the brain. Neurons release neurotransmitters from one neuron to the next via a presynapitc nerve terminal and receptor site at the synapse. The releasing of a neurotransmitter either triggers a message to other neurons in a chain

reaction or a message to disengage signals. There are several neurotransmitters that activate specific receptors site referred to as “ fitting a key into a lock” (Fitzell, 2007). The neurotransmitters include noradrenaline (norepinephrine), and adrenaline (epinephrine), acetylcholine, GABA, glutamate, dopamine, serotonin, opioids and other peptides, and endocannbinoids. Endorphins and enkephalins produce natural opiates in the brain related to intense pleasure.

Noradrenaline (norepinephrine) has a stimulating effect on the brain. It is responsible for regulating the heart, breathing, body temperature, and blood pressure. It also may play a role in hallucinations and depression (Fitzell, 2007). Adrenaline (epinephrine) controls paranoia and the fight-or-flight response. It is also responsible for our appetite and feelings of thirst (Fitzell, 2007). Acetylcholine is responsible for muscle coordination, nerve cells, memory, and is involved in the transmission of nerve impulses in the body (Fitzell, 2007). It has a significant role in reaction to stress.

GABA is found throughout the brain and in numerous sensory neurons (Cruz, Bajo, Schweitzer, & Roberto, 2008). It functions as a regulator of transmitting nerve signals, and it acts on receptor sites, including GPCR, by functioning as an inhibitor. Activation of the receptor sites prohibit the release of neurotransmitters. Ethanol acts as an excitatory for the release of GABA and has a role in alcohol intoxication and contributes to the brain’s hyperexcitable during alcohol withdrawal. Opiods, cannabinoids, and alcohol all act on GABA through the same brain regions.

Glutamate functions as a major excitatory neurotransmitter in the lower brain region (Clapp, Bhave, & Hoffman, 2008). It serves most brain neurons and is found throughout the brain. Two receptors, AMPA and NMDA, appear to be involved in learning and memory. Acute alcohol consumption inhibits the release of glutamate and appears to play a role in inhibiting synaptic plasticity and impairment of memory (Lovinger, 2008). Gass and Olive (2008) studied glutamate's influence on drug addiction. Studies found that all drugs of abuse utilize glutamate transmissions producing a long-term neuroplasticity in the brain. Glutamate contributes to compulsive drug-seeking behavior and drug-associated memories.

Dopamine serves as the most significant neurotransmitter in the brain. It is responsible for controlling our moods, energy, and feelings of pleasure (Fizell, 2007). Dopamine influences brain mechanisms of reward, evaluation of environmental stimuli, general behavioral activity level, and some brain disorders. According to Cruz, Bajo, Schweitzer, and Roberto (2008), dopamine becomes pervasive throughout the brain and is produced by only a few neurons. It is considered a " pure neuromodulator" because it becomes activated only by GPCRs. There are five dopamine receptor sites, D1 through D5. Half of the neurons connect to the substantia nigra pars reticulate forming the direct pathway to activating the cortex (Cruz, Bajo, Schweitzer, & Roberto, 2008). The other half connect to the globus pallidus internal segmane forming the indirect pathway to slow down cortical output. Dopamine controls performance of action, including the intoxication from alcohol and other drugs (Cruz, Bajo, Schweitzer, & Roberto, 2008).

Many drugs target dopamine transmission, and dopamine plays a significant role with all drugs. Cocaine, amphetamine and other stimulant drugs either block or reverse the action of the dopamine transporter (Lovington, 2008). As a result, the level of dopamine in the synapse increases. Research shows that interference with dopamine transmission generates an intoxicating and addictive effect with drugs and alcohol Nicotine and alcohol stimulate dopamine. Morphine and other opiates slow GABA activity and indirectly increase the activity of dopamine. It also contributes to learning environmental cues in relation to the context of drug use that encourages drug and alcohol use.

Fitzell (2007) describes serotonin’s role in the brain as relating to the five senses, sleep, aggressive behavior, eating, and hunger. Its release brings about a sense of calm, happiness, peace, satisfaction, signals of fullness, and reduced appetite. A decrease of serotonin or blockage in the brain cells results in aggression and violent behavior. Low levels of serotonin are associated with depression and increased appetite. Serotonin is a very powerful mood enhancer and appetite regulator located in the base of the brain (Fitzell, 2007).

According to Lovinger (2008), neurons connect to other neurons through the central nervous system, including the cerebral cortex and other forebrain structures. Serotonin influences sensations related to environmental stimuli, perception, learning and memory, and sleep and mood. Serotonin activity involves 15 CPCRs that either increase or decrease neuron output. It is the target of psychoactive drugs, such as LSD, mescaline, and psilocybin that serve as agonists of serotonin. Amphetamines, such as MDMA also known as

ecstasy, interfere with serotonin transporters and increase serotonin levels. It is suspected that the effect may result in sensory-enhanced effects. Alcohol appears to cause a reduction of serotonin uptake.

Opioids and other peptides contribute to the brain’s communication by decreasing excitatory glutamate and inhibitory GABA at the cell level (Cruz, Bajo, Schweitzer, & Roberto, 2008). However, GABA continues to have an excitatory effect throughout the brain producing the pain-relieving effect of opioids as well as opioid dependence. Peptides help neuromodulation of the brain through GPCRs. These peptides serve as agonists to receptor sites for morphine, heroine, and other opiate drugs (Lovington, 2008). Three opiate receptors of importance include mu-type, delta-type, and kappa-type (Befort, et al., 2008). Reduction in opioid peptide actions interfere with promoting an increase in dopamine. Lovinger (2008) describes another hormone of particular importance, the corticotrophin-releasing hormone (CRH). CRH communicates signals of stress, mood, and changes in bodily functions. CRH and its receptors play a role in stress, drug addiction, and relapse. The opioid peptides, endorphins, and enkephalins affect mood, produce intense feelings of pleasure, and can reduce and relieve pain. Endorphins also help in managing stress. Enkephalins help the body fight pain (Fitzell, 2007). Wand (2008) describes a the stress response as involving a glucocorticoid response generated from the hypothalamic pituitary-adrenal (HPA), activation of peptides corticotrophin-releasing factor (CRF), and activation of the sympathetic nervous system releasing epinephrine and nonrepinephrine.

Endocannabinoids (endogenously formed cannabinoids) and other lipid-derived neuromodulators are involved in synaptic communication and acute

reinforcing effects of drugs (Cruz, Bajo, Schweitzer, & Roberto, 2008). Lovinger (2008) describes the receptor site CB1 linked to GPCR as functioning to inhibit the release of neurotransmitters. CB1 acts as agonists and influences both inhibitory and excitatory synaptic transmissions (Cruz, Bajo, Schweitzer, & Roberto, 2008). As a result, a decrease in several neurotransmitters occurs, including GABA and glutamate. A long-term synaptic depression may occur produced by retrograde endocannabinoid signaling. A consequence of this occurrence plays a key role in learning and memory and associated addiction (Lovinger, 2008).

Brain Anatomy of Addiction

The brain attempts to counteract the chemical changes caused by drug addiction. The process of neuroadaption or neuromodulation strives to reinstate homeostasis in the brain. Drug addiction influences all aspects of the brain with several significant regions serving more dominant roles.

The mesotelencephalic dopamine system is a diffuse pathway consisting of dopamine neurons associated with pleasure (Pinel, 1998). Its cell bodies are connected to two structures in the midbrain tegmentum: substantia nigra or the ventral tegmental area. The axons of these two structures extend into different structures in the telencephalic sites. These structures include frontal cortex, striatum, septum, cingulated cortex, amygdala, and nucleus accumbens. The mesotelencephalic dopamine system is associated with motivation of behaviors and self-administering addictive drugs, sexual behavior, and eating (Pinel, 1998)

The substania nigra is a midbrain nucleus of the tegmentum and contains cell bodies of many of the neurons of the mesotelencephalic dopamine system. Its dopaminergic neurons terminate in the striatum (Pinel, 1998). The nigrostriatal pathway is a dopaminergic tract from the substantia nigra to the striatum. The striatum is composed of the caudate and putamen and serves as the terminal of the dopaminergic nigrostriatal pathway. The ventral tegmental area is located medial to the substania nigra and contains cell body of many neurons in the mesotelecephalic dopamine system (Pinel, 1998).

The nucleus accumbens is a nucleus located between the striatum and the basal forebrain. It is a major terminal in the mesotelencephalic dopamine system. It plays a critical role in the experience of pleasure (Pinel, 1998).

Koob and Simon (2009) indicate that the mesocorticolimbic pathway is the brain circuit that transmits dopamine in the rewarding effects of alcohol and other drugs. The mesocorticolimbic dopamine system represents the reward system in the brain. Neural inputs and outputs interact with the dopamine projections from the ventral tegmental area to the basal forebrain (Koob & Simon, 2009; Ikemoto, 2007).

Pinel (1998) describes the prefrontal cortex as the large area of the frontal cortex anterior to the primary and secondary motor cortex. It consists of three large areas: dorsolateral prefrontal cortex, orbitofrontal cortex, and medial prefrontal cortex (Pinel, 1998). The dorsolateral prefrontal cortex is the large area on the lateral surface of the prefrontal lobes and plays a role in memory for temporal sequence of events but not the actual events,

response sequencing, inhibiting incorrect but previously correct responses, developing and following plans of action, and creative thinking. Pinel (1998), indicates that the orbitofrontal cortex is the large area of prefrontal cortex on its anterior pole and inferior surface. Damage to the orbitofrontal cortex results in marked personality changes, an inability to inhibit inappropriate behaviors, and influences social behaviors. The medial prefrontal cortex is the area of the prefrontal cortex on the medial surface of the prefrontal lobes that when damaged, produces a blunting affect (Pinel, 1998).

Amygdala is a major structure in the limbic system. It is an almond-shaped nucleus of the anterior temporal lobe. The central nucleus of the amygdala has the highest density of enkephalins. Enkephalins are found in the cell bodies of GABA neurons, the most abundant type of neuron in the nucleus of the amygdala (Cruz, Bajo, Schweitzer, & Roberto, 2008). The amygdala is responsible for the fight or flight emotional reaction.

The extended amygdala signifies brain structures located near the front of the lower brain region, referred to as the basal forebrain (Befort, et al.). The extended amygdala is comprised of a number of structures, including the nucleus accumbens (NAcc), the central nucleus of the amygdala (CeA), and the bed nucleus of stria terminals (BNST). It plays a role in relation to the acute reinforcing effects of drugs and the negative effects of compulsive drug use and reward. The CeA consists mostly of GABA as inhibitory neurons with neuron connections or project to the brainstem or BNST. It is considered the “ gate” that controls information through the intra-amygdaloidal circuits. Befort, et al. (2008) describes the central extended amygdala (EAc) as a network formed by the central amygdala and the BNST controls. It plays a

significant role in drug cravings, drug-seeking behaviors, drug rewards, and drug dependence.

Hippocampus is the allocortical limbic system structure of the medial temporal lobes and extends from the amygdala at its anterior end to the cingulated cortex and fornix at itsposterior end (Pinel, 1998). The basolateral amygdala mediates motivational effects of drug use and the context associated with drug use in forming emotional memories (Koob, 2009). It plays a major role in learning and memory, particularly in relation to associated drug behaviors.

Feltenstein and See (2008) provide a depiction of the brain anatomy and drug related connections in the mesocorticolimbic system. Dopamine projects from cell bodies in the VTA and connect to limbic structures via the mesolimbic pathway (amaygdala, ventral pallidum, hippocampus, and NAcc, and cortical areas (mesocortical pathway, including the prefrontal cortex, the orbitofrontal cortex, and the anterior cingulated gyrus) (Feltenstein & See, 2008); Ikemoto, 2007). The NAcc and ventral pallidum serve as the primary effects of drug abuse. The amygdala and hippocampus serve a role in learning as it relates to the process of addiction. The amygdala and ventral hippocampus impact learning in discrete stimulus-response associations. The amygdala and dorsal hippocampus impact learning through stimulus-to-stimulus associations important in contextual learning.

The prefrontal cortex, orbitofrontal cortex, and anterior cingulate gyrus regulate emotional responses, cognitive control, and executive functioning (Feltenstein & See, 2008). Feltenstein & See (2008) further indicated that

repeated drug exposure leads to neuroadaptions at the cellular level of the prefrontal NAcc glutamatergic pathway that contributes to the persistent addictive behaviors, including diminished cognitive control and hyper-responsiveness to drug-associated stimuli. The mesolimbic pathway is involved in the acute reinforcing effects of drugs and various conditioned responses related to drug cravings and relapse.

Cycle of Addiction

Drug addiction forms through progressive stages of drug use, impulsivity, and compulsion. Addiction begins with the choice to use drugs for a variety of reasons, such as peer pressure or curiosity; however not everyone who uses drugs develop an addiction. As the drug begins to change neuron interactions, the brain develops neuroadaptive reactions to the drug's invasion. Drug use gradually shifts from recreational drug use to a compulsive drug need based on changes in the brain circuitry. Everitt, et al. (2008) discovered that low levels of dopamine receptors in the nucleus accumbens predict the propensity to escalate cocaine intake and the shift to compulsive drug-seeking and drug addiction.

Kobb (2009) describes three stages of addiction: preoccupation/anticipation, binge intoxication, and withdrawal/negative effect. The three stages feed into each other, become intensified over time, and shift from positive reinforcement to negative reinforcement (Kobb, 2009). Drug use starts with experimentation and enjoying the pleasurable attributes of the drug. In time the addict focuses more on obtaining and using drugs that begins to shift impulsivity to tolerance and cravings in the drug relationship. As the drug begins to control the addict, the positive emotions begin to shift to negative

emotions. The addict requires continued use of the drug in order to avoid negative reinforcement and to achieve positive reinforcement. The addict shifts into a compulsive need for the drug.

According to Koob and Simon (2009), the binge/intoxication stage of addiction involves the nucleus accumbens-amygdala reward system, dopamine inputs from the ventral tegmental area, local opioid peptide circuits, and opioid peptide inputs in the arcuate nucleus of the hypothalamus. The stage of negative withdrawal involves a decrease in function of the reward system and the brain stress neurocircuitry. The preoccupation/anticipation (craving) stage involves key afferent projections to the extended amygdala and nucleus accumbens, specifically the prefrontal cortex (for drug-induced reinstatement), and the basolateral amygdala (for cue-induced reinstatement). Compulsvie drug-seeking behavior appears driven by ventral striatal-ventral pallidalthalamic-cortical loops.

In particular, the orbitofrontal cortex in the prefrontal cortex area influences impulsivity and compulsivity in drug addiction (Torregrossa, Quinn, & Taylor, 2008). It is also critical in decision making and response selection. The orbitofrontal cortex influences impulsivity in three specific ways: delaying gratification, inability to inhibit strengthened motor responses, and an inability to reflect on potential consequences of action (Torregrossa, Quinn, & Taylor, 2008). Schoenbaum and Shaham (2008) concur with the concept of an altered orbitofrontal cortex in drug addicts with a lasting decline in plasticity or the ability to encode new information.

Drugs Classifications Commonly Abused

Drugs commonly abused change the brain’s chemistry by interfering with the neurotransmitters and receptor sites. Different classes of drugs appear to affect different receptors either through overproducing a neurotransmitter or blocking the production of a neurotransmitter. All drugs of abuse share enhancement in the mesocorticolimbic dopamine activity, although at different levels.

Depressants

Ethanol is the primary drug in alcochol. It changes serotonin levels, and acts as a substitute for endorphins. According to Frezell (2007), behaviors that occur when under the influence of the drug include sleepiness, possible violence or aggression, depression, and a dulling of psychological pain. After the effect of alcohol wears off, sleep disturbance, depression, lack of endorphins to relieve normal pain, and cravings for more alcohol occur in reaction to the brain’s reduction in producing endorphins. Cruz, Bajo, Schweitzer, and Roberto (2008), indicate that alcohol increases the inhibitory effect of GABA and decreases the excitatory action of glutamate. GABA is involved with the intoxication effects of alcohol and the long-term effects, including tolerance and dependence. The CeA adapts to the changes as alcohol dependence forms. Feltenstein and See (2008) indicate that ethanol interacts with a wide variety o