# SWK 3805: Module 10- Stimulant Substances

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# Contents

# Module 10: Preface

Welcome to the online coursebook for Module 10 of our Theories and Biological Basis of Addiction course. The material is designed to be read interactively or after downloading; while the embedded interactive exercises require internet connectivity, each can also be downloaded for offline work. These exercises are presented to help you test and apply what you are reading, challenge yourself, prepare for quizzes, and have a little fun along the way. The list of key terms at the end explains text ***highlighted in bold italics*** throughout the book—in the interactive mode you can click on a highlighted word to jump to its explanation in the key terms section. Use the back arrow to return to where you were reading.

# Module 10: Introduction

The reading for Module 10 introduces concepts essential for understanding the nature of various stimulant substances—amphetamines, “uppers,” methamphetamine, cocaine, tobacco, and caffeine. Yes, those last two are included in this module because of the nature of their effects on human behavior and the body. This online coursebook includes content prepared by the book’s author, as well as several readings from the published literature.

**Module 10 Reading Objectives**

After engaging with these reading materials and learning resources, you should be able to:

- Explain what stimulant substances are, how they work, and their effects on the brain, body, and behavior
- Identify epidemiological patterns in the use of various stimulant substances
- Identify specific characteristics of amphetamines, methamphetamine, cocaine, tobacco, and caffeine
- Discuss the potential risks associated with mixing alcohol and energy drinks
- Define several key terms related to substance use, substance misuse, and substance use disorders.

# Ch. 1: Introduction

The first reading for Module 10 presents information about stimulant substances, the epidemiology of stimulant drug use, and the effects of these substances on human bodies and behavior. This topic overlaps to some extent with our discussion of prescription drug abuse to come in Module 13. However, there are many forms of stimulant substances: some are completely legal and unregulated (like coffee and tea), others are semi-regulated (like age restrictions on tobacco products and products requiring a prescription), and some are highly regulated (illegal to manufacture/distribute or possess without a prescription, like methamphetamine). In this way, Module 10 overlaps with the Schedule of Drugs content presented in your Module 9 lecture content.

In this first chapter you will read about:

- The general class of stimulant substances
- Why stimulants might be used in treating attention deficit disorder (ADD) and attention deficit hyperactivity disorder (ADHD)
- Epidemiological patterns in the use of amphetamines, methamphetamine, cocaine, tobacco, and caffeinated beverages
- Key terms related to the class of stimulant substances.

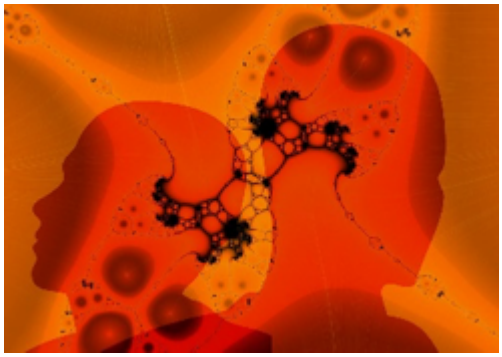
## Introduction to Stimulant Substances

Stimulant substances are generally those with psychoactive effects of increasing alertness, attentiveness/attention, and energy level. Some of these substances are naturally occurring, while others are manufactured or synthetic. ***Amphetamines*** are synthetic drugs that affect the levels of at least four major neurotransmitter systems in the human brain: ***serotonin*****,** ***epinephrine*****,** ***norepinephrine*****,** and***dopamine*****.** You have been learning about these neurotransmitters throughout our course, especially in Module 3 and 4. ***Methamphetamine*** is a specific form of amphetamine. ***Cocaine*** is another stimulant substance, drawn from a naturally occurring source: *erythroxylum* plants (*coca*, *laetevirens*, or *novogranatense* variants).

It should not be surprising, therefore, to find that other types of plants also can have stimulant effects: tobacco leaves(*nicotiana tabacum* plants) and coffee beans (*coffea* plants), for example. Chocolate comes from yet another bean: that of the cacao or cocoa plant (*theobroma cacao* trees).

Stimulant substances have been used medicinally for many generations and across many cultures. In the United States, stimulants have been prescribed to treat several conditions, including attention deficit disorder (ADD), attention deficit hyperactivity disorder (ADHD), narcolepsy, some forms of depression, respiratory problems (including asthma), and as a weight management/weight loss aid.

Significant side effects are associated with the use of amphetamines and other stimulant substances, however. Addiction is one concern. For many of these substances, tolerance develops quickly so individuals use increasingly higher doses to experience the desired effects. Many people experience withdrawal symptoms when stimulants are discontinued: fatigue, depression, headaches, and disrupted sleep patterns are common.



Another possibility that individuals may experience when using stimulant substances (even as prescribed medications) is a significant change in psychological functioning. This might include feeling restless and jittery, mood swings, irritability, and paranoia. Sometimes psychosis is triggered by the use of stimulant drugs. These effects of stimulant "uppers" may lead a person to try using another class of substances to manage them—that would be the substances sometimes called "downers" (CNS depressants) that we studied in Module 9. The emotional effects of stimulant medication pharmacokinetics (rise and fall of levels circulating in the body) is also a reason for the development of extended release stimulant medications: for example, Ritalin® comes in an extended release formulation to even out the effects. Extended release forms of medications are intended to make the therapeutic effects last longer and taper off more gradually. Extreme emotional fluctuations are often experienced by individuals (especially children and adolescents) as a function of their medication blood levels dropping below a therapeutic threshold as the medications are broken down (metabolized) in the body over time—an experience called "crashing" is characterized by a sudden, intense drop in mood, tearfulness, increased symptoms of whatever is being treated with the medication, and sometimes early withdrawal symptoms.

There also are general physiological changes that come with using stimulant substances to consider. For example, these substances reduce appetite, increase heart rate, increase blood pressure, and increase body temperature for most people. This places increased risk of cardiac problems (irregular heartbeat, accelerated heart rate, heart attack), hyperthermia (overheating), and seizures on our list of concerns, along with malnutrition or otherwise unhealthy weigh loss. Children taking stimulant medications may be slow to grow and their progression into puberty may be delayed.

Many of the experienced physiological symptoms are a result of stimulant substances on the human ***autonomic nervous system (ANS)***. This is the nervous system that manages autonomous (automatic) bodily functions—the ones that we do not have to consciously think about. This would be things like maintaining breathing, heartbeat, blood pressure, body temperature, sweating, digestion, and kidney/urinary functions. Two complementary divisions of the ANS allow regulation of body functions in response to internal changes or changes in the environment (this regulation we called homeostasis in our earlier modules). The ***sympathetic nervous system*** runs at a baseline level to help maintain homeostasis. In addition, this system can gear up to create a rapid "fight or flight" stress response to events or stimuli in the environment.


The ***parasympathetic nervous system*** helps bring the body back to its homeostatic resting baseline after arousal. What is the role of stimulant substances in all of this? Most of these substances stimulate the sympathetic nervous system as if there actually were an event warranting a "fight or flight" stress response. The way that these drugs affect the sympathetic nervous system is through their influence on the neurotransmitters ***epinephrine*** and***norepinephrine***. Norepinepherine, when acting as a neurotransmitter, is involved in promoting focused, "vigilent" concentration. This contributes to their often being misinterpreted as "intelligence" producing substances.


Why would we treat ADD or ADHD with stimulant medication? It seems rather paradoxical or counter-intuitive on the surface—a bit like pouring lighter fluid on an already burning fire. Medications like Ritalin®, Concerta®, Adderall®, and Dexedrine® work by increasing the dopamine levels in the brain. Dopamine is responsible for cognitive alertness. This dopamine release improves a person's attention, motivation, and ability to focus. In turn, this directly helps people improve in a whole lot of performance areas, but it also helps more indirectly, as well.


For example, it can improve a person's ability to respond appropriately to social cues, ability to stay on task in school or work activities, ability to control impulsiveness, social relationships, self-esteem, self-confidence, and self-image. Medication alone is not sufficient to manage ADD or ADHD. A lot of hard work to learn coping and self-management skills is also necessary; the medication gives the person a chance for behavioral interventions to be effective. Without medication it is more difficult, but not impossible, for a person with ADD or ADHD to focus attention needed to learn these new intentional behaviors and skills.

People vary widely in their level of response and improvement with this form of medication—some people improve dramatically, others only slightly, and some not at all. However, systematically tested evidence indicates that these performance improvement (cognitive enhancement) effects are not present in individuals who do not have ADD or ADHD—despite widespread popular beliefs (NIDA, 2014). Use of these drugs by this population can actually stimulate hyperactivity while the drug is in their systems. And, of great concern with this form of amphetamine prescription abuse: we have learned that substances with the effect of increasing dopamine also have an increased probability of addiction because of the drug's effects on the pleasure centers of the brain.

## Epidemiological Patterns

Because there are so many different types of stimulant substances to consider, we need to look at the data

concerning their use patterns separately. The NSDUH data (SAMHSA, 2016) indicates that over 1.65 million individuals aged 12 and over misused stimulant drugs in the past month. While males (877,000) did outnumber females (776,000), the ratio by gender was not markedly different.

Think about it, Part 1: Before you read further, spend a moment making note of your own guesses about each of the following epidemiological patterns.

- Place these substances in the order you believe they fall from most to least commonly used by individuals in the United States: amphetamine prescription abuse, methamphetamine, cocaine, tobacco, and caffeinated beverages.
- For each substance, which gender do you think reports the highest rate of misuse?
- For each substance, which racial/ethnic group do you think reports the highest rate of misuse?

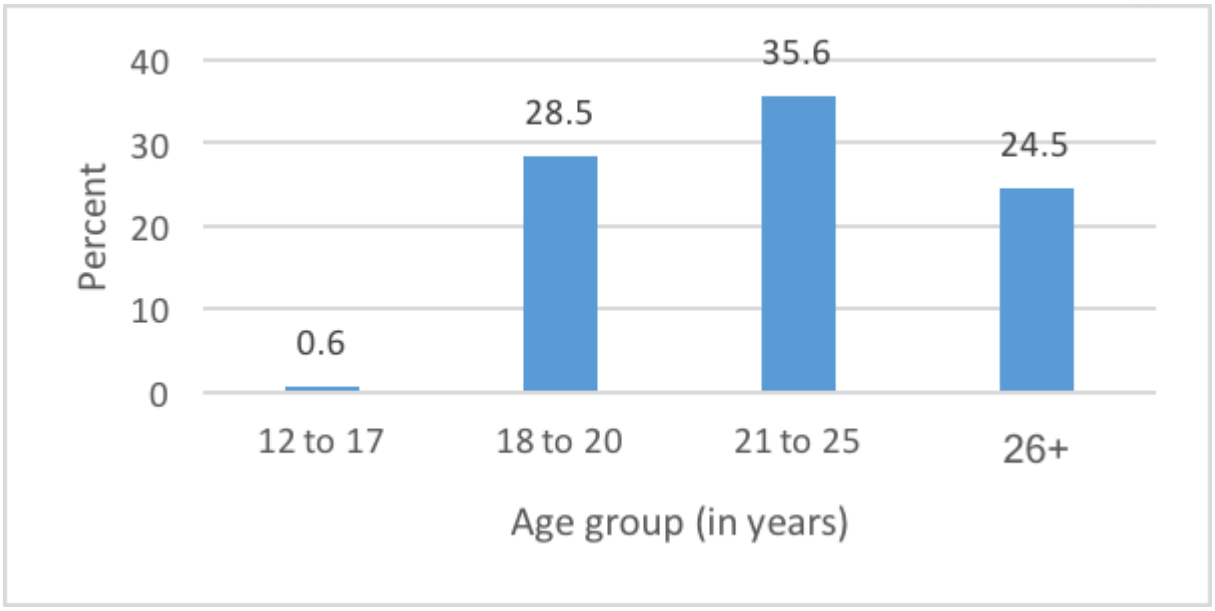
**Amphetamines/Methylphenidate:** The 2015 data indicate that just over 5 million persons aged 12 and older reported current or recent (past month) misuse of prescription amphetamines or methylphenidate (SAMHSA, 2016). Extrapolating from other proportions in the study, this translates to about 1.67% of the population studied. About 500,000 were adolescents aged 12-17 years. There were about 2.5 million in the 18-25 year age group and 2.2 million in the group aged 26 and older.

**Methamphetamine:** Almost 900,000 individuals (0.3%) aged 12 and over recently (past month) used methamphetamine according the 2015 NSDUH survey (SAMHSA, 2016). This most often was reported in large metropolitan areas (461,000) and least often in nonmetropolitan areas (160,000), with small metropolitan areas falling in between (276,000). Regionally, methamphetamine use was most common in the South (375,000) and West (358,000) of the United States and least common in the Midwest (102,000) and Northeast (62,000). Use by males was at a rate more than double that for females, and the largest group using methamphetamine was white.

**Cocaine:** Looking at the 2015 NSDUH data (SAMHSA, 2016) we can see that an estimated 1.88 million persons (0.7%) aged 12 and over engaged in current or recent (past month) use of cocaine. Twice as many were males compared to females in this group, with the most common racial/ethnic group being white (not Hispanic or Latino), and the largest group being employed full-time. Crack cocaine use was relatively uncommon (394,000) among those aged 12 and over.

**Tobacco:** Almost 64 million individuals (24%) aged 12 and older reported recent (past month) use of tobacco products in the 2015 NSDUH survey (SAMHSA, 2016). The vast majority (52 million or 19%) used cigarettes. This is in comparison to cigars (4.7%), smokeless tobacco (3.4%) or pipe tobacco (0.8%). Figure 1 shows the age breakdown of those reporting past month tobacco use.

Figure 1. Past month tobacco use by age group (percent)




**Caffeine:** We have to turn to other sources to estimate the use of caffeinated beverages in the United States; the NSDUH survey does not ask about these substances. In a 2010-2011 population-based study, an estimated 85% of the U.S. population consumes at least one caffeinated beverage daily, with coffee being the primary contributor (Mitchell, Knight, Hockenberry, Teplansky, & Harman, 2014). Over the years, research has vacillated about the health benefits versus risks of drinking coffee. In studies that suggest benefits, the caffeine is not the factor contributing to protecting one's health—it is other components in the coffee, many of which are still present in decaffeinated coffee, depending on the method used to decaffeinate the product (Gunter et al., 2017). And, the health risks accumulate with the flavorings we might add, such as high fat and calorie dairy and caloric sweeteners.

In addition to coffee, carbonated soft drinks, tea, and energy drinks/energy shots account for most of the caffeine consumed. Tea and carbonated soft drinks (like colas, Sunkist® orange, Dr. Pepper ® and Mountain Dew®) accounted for a great percentage of caffeine consumed by children and adolescents in the United States. Energy drinks accounted for less than 10% of the caffeine consumed by any age group, with the greatest use of energy drinks appearing in the 13-17 and 18-24 year old groups.


Now compare your predictions to what you read.

- The order they fall from most to least commonly used by individuals in the United States: caffeinated beverages (85%), tobacco (24%), amphetamines (1.67%), cocaine (0.7%), and methamphetamine (0.3%).
- For each substance except caffeinated beverages (that study did not analyze by gender), males more frequently reported using than females.
- For each substance, white non-Hispanic/non-Latino individuals most frequently reported using (except caffeinated beverages, that study did not analyze by race/ethnicity).

### Substance Use Disorders Involving Stimulants

These stimulant use patterns, however, are only part of the picture. It is important to know how frequently people developed stimulant-related substance used disorders, too. Let's look at the data from the NSDUH (SAMHSA, 2016) survey on this point.

- 29 million individuals met criteria for nicotine (cigarette) dependence; this is over half (55.7%) of persons who reported recent (past month) smoking of cigarettes.
- 896,000 individuals aged 12 and older met criteria for a substance use disorder involving cocaine; 702,000 were in the 26 and older age group.
- 872,000 individuals aged 12 and older met criteria for a substance use disorder involving

methamphetamine.

- 426,000 individuals aged 12 and older met criteria for a substance use disorder involving simulant prescription misuse.

### Age at Initiation

Finally, because we know that age at first use of substances plays a significant role in the probability of developing a substance use disorder, it is helpful to know the patterns in when young people start using. The 2015 NSDUH survey (SAMHSA, 2016) data indicate the following:

- 1.26 million persons initiated stimulant misuse during the past year; this represents 0.5% of the population
- 276,000 initiates of stimulant misuse were aged 12-17 years
- 600,000 initiates of stimulant misuse were aged 18-25 years
- 384,000 initiates of stimulant misuse were ages 26 or older

Perceived risk is considered to be one of the protective factors related to substance use initiation. However, among persons who began smoking cigarettes during the past year, 645,000 perceived there to be great risk in smoking one or more packs per day. Among persons who never initiated smoking, 779,000 held this perception. Perhaps those who initiated smoking did not believe there to be much risk in smoking less than a pack per day and did not anticipate eventually smoking in what they considered to be a high-risk pattern.

Among persons who initiated cocaine use during the past year, 228,000 perceived there to be great risk in using once a month and 478,000 perceived this level of risk associated with using once or twice a week. Individuals who never initiated cocaine use MUCH more commonly held the belief that it was used at great risk.

# Ch. 2: Cocaine

The focus of this chapter is cocaine. While it is not the most commonly misused of the stimulant substances, its misuse is associated with considerable numbers of persons experiencing serious physical health, mental health, and life problems as a result. Thus, this substance warrants a closer look. The reading selected for this chapter is from the National Institute on Drug Abuse and is simply titled *Cocaine* (NIDA, 2016).

In this chapter you will read about:

- what cocaine is and how it is used
- statistics about the use of cocaine in the United States
- cocaine's effects on the brain, short- and long-term effects of use, and how the effects of cocaine are produced
- risk of communicable diseases with cocaine use (HIV/AIDS and hepatitis)
- effects of maternal cocaine use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# Ch. 3: Methamphetamine

This chapter is focused specifically on the topic of methamphetamine. While methamphetamine (meth) is not the most commonly misused of stimulant substances, there exists a sizeable population of individuals, families, and communities experiencing powerfully negative consequences. The contents of this chapter are in the NIDA (2013) Research Report Series article about methamphetamine.

In this chapter you will read about:

- what methamphetamine is and how it is abused
- danger in the manufacture of methamphetamine
- how methamphetamine compares to other stimulant substances
- short- and long-term effects of methamphetamine, including the dopamine pathways involved
- risks associated with methamphetamine use during pregnancy
- risk for communicable diseases (HIV/AIDS and hepatitis) with methamphetamine use


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# Ch. 4: Tobacco and Nicotine

In this chapter you will read two articles from the National Institute on Drug Abuse. The first discusses tobacco: specifically, nicotine (NIDA, 2016). The second is about a relatively new phenomenon—the e-cigarette. While some people believe that the e-cigarette represents a harm reduction approach to smoking and nicotine addiction, evidence about the level of harm associated with using e-cigarettes is growing. This is the topic of our second reading in this chapter (NIDA, 2017).

In this chapter you will read about:

- The epidemiology of tobacco/nicotine use (from data a bit older than was presented in chapter 1)
- Effects of tobacco use, including addiction
- Tobacco use and other health risk behaviors, comorbidity, and pregnancy
- Treatment approaches for nicotine addiction
- E-cigarettes

Two additional points to consider when you review the second article:

- The batteries used in some-cigarette brands have been known to malfunction, just as some other forms of rechargeable battery products recently in the news, causing fires, burns, and injuries (they are banned on airplane flights).
- The liquid nicotine (“e-juice”) use in e-cigarettes is highly toxic to young children and pets if they are exposed to it. The nation’s poison control centers report a sharp increase of 1500% in calls about this type of overdose in the 3-year period between 2012 and 2015, usually involving children under the age of 6, and especially children under the age of 2 years (LaMotte, 2016).


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# Ch. 5: Caffeine

Our final topic in this module about stimulant substances concerns ***caffeine***.

In this chapter you will read some general information about caffeine that is edited from a pair of NIDA blog sites: The Buzz on Caffeine and Is Caffeine Really Addictive?

In this chapter you will read about:

- Caffeine being the most widely used psychotropic drug in the United States
- Caffeine effects
- Caffeine content of various products (more about this is in your lecture content)
- Caffeine and addiction

**Here is what the two blogs had to say.**

Question: What's the most widely used drug? It's not marijuana—and it is not tobacco or alcohol either. Nine out of 10 Americans take it in some form every day, and it is not limited to adults.

Hint: According to a recent study published by the American Academy of Pediatrics, nearly three-fourths (75%) of children, teens, and young adults use it daily too—in the form of soda, coffee, and energy drinks.

Answer: Caffeine!

Yes, caffeine is a drug—a stimulant drug, to be exact. It is even possible to be physically dependent on it—which means that a person who is used to drinking lots of caffeinated beverages can experience withdrawal symptoms if they quit.

### Caffeine: Breaking Down the Buzz

Caffeine has a perk-up effect because it blocks a brain chemical, adenosine, which causes sleepiness. On its own,

moderate amounts of caffeine rarely cause harmful long-term health effects, although it is definitely possible to take too much caffeine and get sick as a result.

Consuming too much caffeine can make you feel jittery or jumpy—your heart may race and your palms may sweat, kind of like a panic attack. It may also interfere with your sleep, which is especially important while your brain is still developing. [And, in injury prevention, as well.]

Some caffeine drinks and foods will affect you more than others, because they contain very different amounts.

| Caffeine Source | Caffeine Content |
|---|---|
| 8 oz black tea | 14–70 milligrams (mg) |
| 12 oz cola | 23–35 mg |
| 8.4 oz Red Bull | 75–80 mg |
| 8 oz regular coffee | 95–200 mg |
| 1 cup semi-sweet chocolate chips | 104 mg |
| 2 oz 5-Hour Energy Shot | 200–207 mg |

But it is more than just how much caffeine a beverage has that can make it harmful. Even though ***energy drinks*** do not necessarily have more caffeine than other popular beverages (unless you take 8 ounces of 5-Hour Energy Shot®, which has 400 milligrams!), it is the way they are sometimes used that worries health experts.

In 2011, of the 20,783 emergency room visits because of energy drinks, 42% were because the user combined them with other drugs (e.g., prescription drugs, alcohol, or marijuana).

**Caffeine + Alcohol = Danger**

Mixing alcohol and caffeine is serious business. As a stimulant, caffeine has the opposite effect on the brain as alcohol, which is a depressant. But don’t think the effects of each are canceled out! In fact, drinking caffeine does

not reduce the intoxication effect of alcohol (that is, how drunk you become) or reduce its cognitive impairments (that is, your ability to walk or drive or think clearly). Caffeine does reduce alcohol's sedation effects, so you feel more awake and probably drink for longer periods of time, and you may think you are less drunk than you really are. That can be dangerous. People who consume alcohol mixed with energy drinks are 3 times more likely to binge drink than people who do not report mixing alcohol with energy drinks.

**Stay Away From Caffeine?**

Drinking a cup of coffee, or eating a bar of chocolate, is usually not a big deal. But there are alternatives to caffeine if you're looking for an energy burst but don't want to get that jittery feeling caffeine sometimes causes. Here are a few alternatives you can try to feel energized without overdoing the caffeine:

**Sleep.** This may sound obvious, but getting enough sleep is important. Teens need 9 hours of sleep a night.

**Eat regularly.** When you don't eat, your glucose (sugar) levels drop, making you feel drained. Some people find it helpful to eat four or five smaller meals throughout the day instead of fewer big meals.

**Drink enough water.** Since our bodies are more than two-thirds $H_20$, we need at least 64 ounces of water a day.

**Take a walk.** If you're feeling drained in the middle of the day, it helps to move around. Do sit-ups or jumping jacks. Go outside for a brisk walk or ride your bike.

**Is Caffeine Addictive?**

Most adults in the U.S. use caffeine, whether in coffee, soda, energy drinks, or chocolate. Many are also familiar with the effects of suddenly drinking less coffee than usual: tiredness, headaches, insomnia, and other symptoms. And many people talk about being "addicted" to their morning coffee or energy drink! But is caffeine truly addictive?

**It's all about the dopamine**

The world's caffeine obsession can be described as a "dependency" (because when you have less of it, you go through a mild "withdrawal," with the symptoms listed above), but it is *not* usually an addiction [because not enough DSM-5 symptoms are usually involved].

It is true that—like many drugs—caffeine enhances dopamine signaling in the brain. Dopamine is a chemical that helps control movement, motivation, and emotions, so enhanced dopamine signaling makes a person feel more awake and alert. Because caffeine produces that alert feeling, it is classified as a stimulant.

But some prescription drugs and the dangerous drug methamphetamine ("meth") and MDMA (ecstasy or Molly) are also types of stimulants. So what is the difference?

While caffeine produces a small rise in dopamine, it does not cause the large surge that unbalances the reward circuits in the brain and is necessary for an addiction. So even though the word "addiction" is often used casually, caffeine is not truly addictive (scientifically speaking).

It is all in how you define addiction: NIDA defines addiction as the uncontrolled (or "compulsive") use of a substance even when it causes negative consequences for the person using it.

So the difference between caffeine dependence and addiction to drugs like meth is that even a person who loves to drink coffee can do without it, deal with the headaches and irritability that result, and not engage in destructive (or self-destructive) behavior.

Too much caffeine—like too much of anything—can still be harmful. But even if you just must have that energy drink, know that your love of caffeine doesn't compare to a *real* drug addiction that can change your life forever, in very bad ways.

# Ch. 6: Energy Drinks and Alcohol

In this chapter we are going to explore an issue that overlaps with our Module 8 topic: alcohol. If you stop to think about it, you might wonder how the stimulants topic overlaps with the alcohol topic when alcohol is a central nervous system (CNS) depressant. As you learned in chapter 1, it is not uncommon for individuals to try modifying the effects of one substance by using another (antagonist) substance—offsetting the effects of stimulants with depressants, for example. We are looking directly at alcohol and stimulants here because of the relatively common practice among young people who misuse alcohol to mix alcoholic beverages with energy drinks. The article you will review at this point is Roemer, A., & Stockwell, R. (2017). Alcohol mixed with energy drinks and risk of injury: A systematic review. *Journal of Studies on Alcohol and Drugs, 78*(2), 175-183. The important segments of this article for the purposes of our course are the introduction, results, and discussion. The methodology of a systematic review is relevant to coursework about evidence and evidence-informed practice.

In this article you will read about:

- increased risk of injury following use of alcohol mixed with energy drinks (AmED)
- why increased risk of mixing these substances might occur


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What is the major conclusion to draw from the article's review?

# Ch. 7: Summary

In this Module 10 online coursebook, you learned some basic principles about the class of stimulant substances. As you can see, the class of psychoactive stimulant substances is quite diverse. In this Module 10, we explored a number of different substances that fit into this classification:

- amphetamines,
- methamphetamine,
- cocaine,
- tobacco, and
- caffeine.

We learned a bit about the effects of these substances on the human body and behavior. We also looked into the mechanisms by which they have their effects. You read about the different epidemiological patterns by which these different substances are used by individuals in the United States, and may have been surprised by data challenging some stereotypes. Finally, we explored some of the risks associated with the pattern of mixing the stimulants in energy drinks with alcohol.

You are now ready to review some of the key terms related to substance use disorders introduced in this book.

# Module 10: Key Terms

**amphetamines**: potentially addictive stimulant substances that affect the serotonin, epinephrine, norepinephrine, and dopamine levels in the brain.

**autonomic nervous system (ANS)**: in contrast to the central nervous system (CNS), this system regulates many of the body's functions that generally operate without us having to consciously think about them (autonomous functions); it is functionally divided between the complementary sympathetic and parasympathetic systems, as well as the enteric nervous system.

**caffeine**: widely used central nervous system stimulant substance found in food and beverage products that can cause anxiety and sleep disorders.

**cocaine**: psychoactive stimulant drug derived from natural plant sources; high addictive potential. "Crack" is a form of cocaine.

**dopamine**: one of the major neurotransmitters; a precursor of epinephrine in the human body.

**energy drinks**: beverage containing stimulant substances, usually caffeine; may contain other stimulants and sugar, as well.

**epinephrine**: both a hormone and medication (also called adrenalin as it is produced by the adrenal gland) but also an excitatory neurotransmitter produced by certain neurons.

**norepinephrine**: both a hormone and neurotransmitter; plays a role in attentiveness, emotions, sleep, dreaming, learning, and mood disorders.

**parasympathetic nervous system**: acts in complementary manner to the sympathetic nervous system as part of the autonomic nervous system, calming the system back to homeostatic baseline resting state.

**serotonin**: one of the major neurotransmitters; plays a role in mood, social behavior, appetite, sleep, memory and sexual function.

**sympathetic nervous system**: serves as the mechanism for the "fight or flight" response by stimulating breathing and heart rate, and regulating other organ functions to create a state of arousal; part of the autonomic nervous system, complemented by the parasympathetic nervous system.

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