FLIGHT SAFETY FOUNDATION
HUMAN FACTORS & AVIATION MEDICINE

Vol. 35 No.2 March/ April 1988

Caffeine Can Pick You Up or Let You Down

This popular natural stimulant is found in coffee, cola drinks and prescription drugs. It can be an aid against fatigue, but it can create unwanted side-effects too.

by

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Caffeine consumption possibly started with Paleolithic Man who lived among the principal caffeine-containing plants (23). Caffeine is a naturally occurring component found in coffee beans, tea leaves, cola nuts, cocoa beans and other plants. Today, coffee is the primary source of caffeine in the Western Hemisphere.

For example, the annual consumption of green coffee in the United States during 1980 was about 2.4 billion pounds of coffee, according to the U.S. International Trade Commission (USITC Publication 841, December 1981). This provided an estimated 28.1 million pounds of caffeine. Cola-type drinks and tea contain considerable amounts of caffeine and are additional sources of caffeine for the public at large.

The great popularity of caffeine-containing beverages is due mostly to the stimulating properties of caffeine. Diminished fatigue, improved mood and a temporary increase in physical and mental work capacity result from caffeine intake. It has been reported that the average individual intake of caffeine in the U. S. is above 200 mg daily (an average cup of coffee contains about 100 mg of caffeine) (9, 27). Approximately 75 percent to 90 percent of U.S. caffeine consumption results from drinking coffee (11, 23). The average caffeine content per cup of several caffeine-containing beverages is shown in table one.

Another source of caffeine is prescription drugs that are used for various purposes and contain caffeine in their formulation. The caffeine content per tablet or capsule of several non-prescription "over-the-counter" drugs is shown in table two (2). In addition, there are many prescription drugs that contain caffeine in combination with other chemical substances. A number of these drugs are used for the relief of migraine headache and for the relief of pains of various types, especially muscle and joint pains (19). The caffeine content per tablet or capsule of some popular prescription drugs is shown in table three (2).

Physiological and Psychological Effects Are Significant

Caffeine is an alkaloid, structurally identified as 1,3,7-trimethylxanthine. The chemical formula of caffeine is shown in table four. It is a "xanthine" derivative found in those plants cited previously. Caffeine dissolves readily in hot water. It is odorless and has a bitter taste. It forms combinations with sodium benzoate and sodium salicylate It is not degraded during routine beverage processing by temperature, acidity or salt concentrations. It can, of course, be intentionally removed during commercial processing. Caffeine, as well as its "chemical cousins", theophylline and theobromine, excites the central nervous system, increases urine production, stimulates cardiac muscle and relaxes bronchial muscle.

Caffeine is rapidly absorbed when taken by mouth, and reaches peak levels in the body tissues about one hour after ingestion. The average "pharmacologically active" dose (the dozes that produces the level of stimulation many persons seek) matches the average daily caffeine intake in the U.S. of 200 mg (11). Individuals who consume moderate quantities (80-200 mg of caffeine per day) of caffeine-containing beverages often experience less drowsiness shortly thereafter, less fatigue and an increased capacity for muscular work.

In addition, they often show an increased capacity for sustained intellectual effort, a shorter visual reaction time, an improved

auditory vigilance and a more rapid and improved association of ideas (8, 11, 14, 23). Caffeine helps to repress the tendency toward "response blocking" that is generated by an extended performance of a monotonous task (1).

These improvements usually occur most significantly among individuals who have a temporary degree of degraded performance resulting from sleep-deprivation and/or fatigue, and to a lesser extent, among individuals under "normal conditions" of plenty of rest (4, 5). It has been noted that a "single dose" of caffeine of 150 to 250 mg (equivalent to two cups of ground coffee or one Vivarin tablet) can produce deterioration of performance on a psychomotor task that requires very delicate muscular coordination and very accurate timing (10, 15). This is because caffeine will produce a slight tremor due to its excitatory effects on the nervous system.

High Doses Cause Problems

The resulting effects of consuming more than 300 mg of caffeine as a single dose or in a short time period resemble "anxiety-like" symptoms that include nervousness, restlessness, insomnia, mild involuntary trembling and increased sensitivity to touch, pain, or other sensory stimulations (5, 25). The effects of high doses of caffeine on the cardiovascular system include tachcardia, and, for certain caffeine-sensitive individuals, cardiac arrhythmias. At high doses caffeine can also produce a decrease of cerebral blood flow and in oxygen tension of the brain, plus an increase in acid-secretions of the stomach (11). At a dose of 400 mg, caffeine can produce an increase in an individual's reaction time (6).

Regular Users Experience Side Effects

In regard to protracted continuing use of large amounts of caffeine, restlessness, insomnia, tachycardia and extra heart beats are common effects. Mood improvements and performance increases that are experienced by caffeine users contribute to the motivation for consumption despite the potential for the previously cited adverse side effects (13). Individuals addicted to caffeine can experience withdrawal symptoms if they interrupt the consumption of this drug. A certain degree of psychological dependence can develop. As with other drugs of abuse, caffeine can have an habituation property. Regular heavy consumption of caffeine does not actually diminish its ultimate stimulant effects, but, when the caffeine intake is then interrupted, certain individuals can develop a "caffeine-withdrawal) headache (7, 11). Other caffeine-withdrawal symptoms include fatigue, drowsiness, laziness, decreased vigor, irritability and decreased alertness. Withdrawal symptoms usually peak within one or two days after interruption of caffeine consumption, and diminish progressively over the next five or six days (12). Therefore, should one become addicted to caffeine, a gradual reduction of the daily intake will minimize or prevent withdrawal symptoms.

Fatal Overdose Isn't Likely

Following the ingestion of one gram of caffeine, individuals can present adverse symptoms and signs due to the excessive central nervous system stimulation. These may be manifested as mild delirium and sensory disturbances, including "ringing" in the ears (tinnitus) and "flashes of light" sensations. Vomiting and convulsions are possible results of large caffeine overdosage. Fatal poisoning in man by the ingestion of caffeine is extremely rare, and few cases have occurred following excessive consumption of caffeine-containing drugs. The acute human fatal dose appears to be greater than 10 g of caffeine administered in a single dose (11).

Pilot Performance Reduced

Caffeine consumption is a potential operational and medical problem because a large segment of the adult population in many countries consumes enough caffeine to produce substantial effects on a number of organ systems. This problem is especially important among groups of people whose occupations involve the operation of complicated equipment. It is also significant when a person's sensory integrity (vision, hearing, touch), and adequate cognitive and psychomotor performance, are required to operate at a high level of function. Pilots deserve special attention here because of the complexity, accuracy and precision required to fly an aircraft. Consumption of high amounts of caffeine (more than 300 mg a day) can produce deterioration of psychomotor performance and changes in mood which can impair a pilot's efficiency and effectiveness to operate an aircraft. It should be noted that since some tolerance to caffeine develops, that, over time, a bit more caffeine is required to produce the same effect. This is a quality of drugs of abuse.

Caffeine and Alcohol Don't Mix

An additional consideration regarding caffeine consumption deserves further attention. This is the common practice of combining caffeine with other drugs such as alcohol and nicotine. It has been reported that alcohol doses of 0.5-0.6 g per kg of body weight (equivalent to blood alcohol concentrations of 40-60 mg/100 ml) are sufficient to impair psychophysiological performance (3). Complicated tasks that include components of risk-taking and hazard perception are also affected by alcohol consumption (26).

Caffeine does not counteract the depressant effects of alcohol. Some studies have shown evidence that the adverse psychophysiological effects of alcohol might be accentuated by subsequent caffeine ingestion (22, 16). Therefore, the cognitive, perceptual and motor functions required to fly an aircraft could be further impaired by the combined effects resulting from the consumption of alcohol and caffeine taken in the same

time period. In addition, performance is adversely affected during the alcohol hangover-phase following alcohol consumption because of the intracellular metabolic changes produced by alcohol withdrawal (18). During the hangover phase, many individuals have a tendency to drink more coffee in order to become more reactive, less fatigued and improve the mood. Therefore, an excessive ingestion of caffeine for the purpose of counteracting the effects of an alcohol hangover can degrade even more an individual's performance on a complex task.

Cigarettes and Caffeine Diminish Performance

Nicotine is another commonly used drug that has specific stimulant and toxic properties. It increases the state of alertness in those undergoing nicotine withdrawal, as is also the case with memory and attention (note: nicotine withdrawal symptoms begin to occur about twenty to thirty minutes after the last cigarette on the average).

Nicotine produces vasoconstriction, increased heart rate and increased blood pressure. The combustion of tobacco releases carbon monoxide which produces hypoxia in the smoker. Also, nicotine in regular use decreases caffeine's metabolic half-life, so that caffeine remains metabolically active for approximately three hours in smokers as compared to 4.5 to seven hrs. among non-smokers (21). The combination of cigarette smoking and caffeine consumption has an additive effect that adversely affects human psychophysiological performance (24).

Consume Caffeine Carefully

1. If a pilot wishes to take advantage of the mild stimulant properties of caffeine but does not want to encounter adverse reactions, caffeine-consumption should be limited to a maximum of 300 mg per day or 200 mg in a single-dose (one cup of coffee equals about 100 mg of caffeine). If some physical or mental fatigue exists, one can get temporary relief by ingesting caffeine at the suggested dose. The preferable solution, of course, is to obtain an adequate sleep period. More information on these issues of relevance to pilots is available in previous issues of this bulletin (17, 20).

2. Caffeine should not be considered a countermeasure against the depressant effects of alcohol.

3. Pilots should be aware of sources of caffeine in many non-prescription and prescription drugs that might increase the daily caffeine-intake above the suggested limits. It is important to remember that a large single dose of caffeine can be more detrimental to fine psychomotor performance than is the case where the dose is divided throughout the day.

4. Caffeine is a potential drug of abuse and individuals who have ingested large amounts over months and years can experience unpleasant withdrawal symptoms when the caffeine consumption is interrupted. ◊

Table One

Caffeine Content per Cup of Various Popular Beverages

Roasted or ground coffee.....85-110 mg
Instant coffee.....60mg
Decaffeinated coffee.....3mg
Brewed Tea.....50mg
Instant tea.....30mg
Cocoa or chocolate.....5mg
12-oz (360 ml) bottle of a cola drink.....50mg

Table Two

Caffeine Content per Tablet or Capsule of Various Non-Prescription Drugs.

Cold and Allergy Relief Drugs
- Alpha-Phed.....32mg
- Sinarest.....30mg
- Tussirex.....25mg
- Dristan.....16mg

Headache Relief Drugs
- Excedrin.....65mg
- Anacin.....32mg
- Vanquish.....33mg

Stay-Awake Drugs
- Vivarin.....200mg
- Efed II.....200mg
- No Doz.....100mg

Appetite Control Drugs
- Dexatrim.....200mg
- Codexin.....200mg
- Prolamine.....140mg

Table Three

Caffeine Content per Tablet or Capsule of Various Prescription Drugs

Migraine Relief Drugs
- Cafergot.....100mg
- Migralam.....100mg
- Wigraine.....100mg

Pain Relief Drugs
- Esgic.....40mg
- Fioricet.....40mg
- Fiorinal.....40mg
- Damason.....32mg
- Norgesic.....30mg
- Synalgos.....30mg

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