placebo). Caffeine consistently enhanced performance on auditory vigilance tasks, improving the number of times a target tone was detected without raising the false alarm rate. The improvement was evident in even the smallest of doses (32 mg) and was dose-dependent. Caffeine also improved performance on a four-choice auditory reaction-time task in one study, but failed to significantly influence performance on this task in a second study. Mood state was also affected, with subjects reporting increases in subjective vigor, alertness, and efficiency and reductions in subjective depression and anxiety. Effects on learning and memory were modest, but tended to improve with caffeine, especially the learning of a complex, visuospatial learning task in which a dose of caffeine appeared to enhance learning about as much as did 64 trials of practice. There was no measure of mood or performance that revealed a negative consequence of caffeine administration. Thus dietary doses of caffeine have consistently measureable and positive influences upon vigilance and mood, and milder but also positive influences upon memory performance. With the exception of performance on vigilance tasks, however, the significance of these effects varies from study to study, suggesting that there are important intervening factors, such as personality characteristics, that mediate the effect of caffeine upon performance, mood, and memory.

THE EFFECTS OF CAFFEINE ON SALIVARY CORTISOL LEVELS AND PERFORMANCE DURING SLEEP DEPRIVATION. Larry T. Matteson, Paul Naitoh, Timothy Elsmore, Tamsin L. Kelly, Steven A. Gomez and Robert Rubin. Naval Health Research Center, San Diego, CA; University of California, Los Angeles.

Volunteers from the Naval School of Health Sciences participated in a study of the effects of caffeine on salivary cortisol and caffeine levels, as well as behavioral performance measures, during a 64-hour sleep loss period. Subjects in a double-blind design received low (150 mg caffeine every 6 hours; 7 doses), moderate (300 mg caffeine every 6 hours; 7 doses), high (400 mg caffeine every 12 hours; 2 doses), or placebo (every 6 hours; 7 doses), over a 64-hour continuous work period. Drug administration for all groups commenced at 2320 during the first night of sleep loss. Preliminary results from the assays document the appropriate caffeine levels following the various drug doses, and showed the usual circadian fluctuations in cortisol levels. Further, the data suggest there are no sleep deprivation or drug-related alterations in cortisol levels. Implications of these findings and their relationship to behavioral measures will be discussed.

CAFFEINE AND COGNITIVE PERFORMANCE: DATA AND A THEORETICAL MODEL. Kristen Joan Anderson. Northwestern University, Evanston, IL.

Data regarding the effects of caffeine on human cognitive performance will be reviewed. Results from a series of studies suggest that caffeine reliably interacts with time of day, the personality dimension of impulsivity, and task components to determine the efficiency of cognitive performance. On very easy tasks, caffeine tends to facilitate performance regardless of personality or time of day. On complex tasks, however, caffeine interacts with impulsivity and time of day—in the morning, caffeine facilitates the performance of impulsives but hinders that of nonimpulsives; in the evening, this interaction reverses. This pattern of results can be understood if the following assumptions are made: (a) The cognitive effects of caffeine, impulsivity, and time of day are all mediated by arousal (or activation). In comparison to nonimpulsive individuals, those who are high in impulsivity are less aroused in the morning but more aroused in the evening. Caffeine, a central nervous system stimulant, consistently increases arousal. (b) Performance is an inverted-U function of arousal, with the optimal level of arousal for performance being a negatively monotonic function of task difficulty. In combination, these assumptions allow prediction of the observed high-order interactions between caffeine, impulsivity, time-of-day, and task difficulty, but do not explain the relationship between arousal and performance. Additional research, again employing caffeine as well as other arousal variables, suggests that arousal has different effects upon several components of information processing. Specifically, arousal appears to facilitate the ability to sustain attention and to process information quickly, but to hinder the ability to retain information in available form for brief intervals. In addition, arousal at time of learning may facilitate long-term memory independent of any state-specific learning effects. In summary, caffeine appears to have systematic effects on several aspects of cognitive processing, and these effects appear to be mediated by caffeine's arousing properties.

THE SCIENCE AND REGULATORY STATUS OF CAFFEINE AS A FOOD CHEMICAL. Thomas J. Sobotka. Food and Drug Administration, Washington, DC.

Caffeine is one of the most widely used chemicals in the world stemming principally from its presence in food as a natural constituent (coffee, tea, chocolate) and as an added substance (soda water). In 1959, based on available information, the Food and Drug Administration (FDA) included caffeine in the category of food chemicals "generally recognized as safe" (GRAS). Over the ensuing years, a considerable database has been developed about caffeine, including its effects on the nervous system. Although caffeine is commonly associated with its mild stimulant effects on performance, experimental information has revealed that exposure to caffeine may under certain conditions also be associated with unwanted effects, such as anxiety, tension, disturbed sleep, irritability, withdrawal headache, and neurofunctional effects in the developing organism. In view of the potential health implications of prolonged use of caffeine, the FDA has initiated a process to reevaluate the regulatory status of caffeine as a food additive. Some of the unique scientific issues involved in this process will be discussed.

CAFFEINE CONSUMPTION: RISKS AND BENEFITS. Harris R. Lieberman. U.S. Army Research Institute of Environmental Medicine, Natick, MA.

The unique status of caffeine as a food, drug and food additive will be discussed. Some of the potential risks and benefits of consumption of this substance will be reviewed in the context of the papers presented at this symposium. When appropriate, data from the literature will also be utilized, including information from epidemiologic studies on potential medical risks of caffeine consumption. Dose, mode of administration, prior history of caffeine consumption, and personality type will be considered as factors modulating responsiveness to caffeine. Behavioral methods will be considered with regard to selection of those that are appropriate to reveal effects of caffeine. Deficiencies associated with specific methods will be discussed. Data from laboratory studies will be related to possible practical consequences of caffeine consumption in a variety of operational situations and in daily life.