

# Smoke Gets in Your Brain

Warning: Cigarettes may be hazardous to your thoughts

By BRUCE BOWER

**T**he Transportation Department announced in December a proposal to mandate random, on-the-job tests for alcohol use among 7 million transportation workers, including truck drivers, railroad employees, airline pilots, air traffic controllers, merchant mariners, and mass transit workers. The proposal, designed in response to a number of alcohol-related transportation accidents in the past few years, follows the enactment in 1990 of random testing for illegal drug use among the same workers.

But if emerging evidence regarding the effects of cigarette smoking on memory and thinking holds up, safety-minded federal officials may need to consider regular testing of transportation workers for the presence of another ubiquitous, thoroughly legal drug — nicotine.

Those little nicotine-laden tobacco sticks that approximately 54 million U.S. adults regularly incinerate and inhale give many users a sense of calm and heightened concentration, despite the well-documented health risks linked to cigarette use. As if promoting cancer and heart disease were not enough, cigarette smoking may also interfere with the ability to draw on all of one's memory and experience when confronted with a particularly complex task, such as making an emergency landing of an airplane or navigating a car on a wet road after a tire blows out, contends psychologist George J. Spilich of Washington College in Chestertown, Md.

"As long as the sky is sunny and no major mechanical problems occur, a driver or pilot who smokes won't have any problems," Spilich argues. "If a storm moves in and there's an equipment failure, my data suggest that the smoker is at a disadvantage."

Spilich's study comes on the heels of a decade's worth of research that has uniformly charted modest boosts in attention and memory following nicotine ingestion through cigarettes, tablets, patches, or injections. But those studies have focused on relatively simple tasks, such as remembering words from a briefly studied list or recognizing nonsense words inserted in a rapidly pre-

sented list, Spilich argues. When cigarette users face tougher challenges, any mental advantages attributed to nicotine go up in smoke, the psychologist contends.

Some nicotine investigators view Spilich's new study with skepticism, especially given its contradiction of their prior findings. Others view his results as intriguing and worthy of further research. In fact, nicotine, like many drugs that affect mental function, may have a two-pronged effect, according to one researcher: It enhances attention and memory at low doses and on basic tasks but takes a toll on mental dexterity at higher doses and on complex tasks.

**S**pilich and his colleagues, whose study appears in the September 1992 *BRITISH JOURNAL OF ADDICTION*, presented five increasingly complex tasks to 288 college students divided into three categories — smokers of at least one pack of cigarettes a day who had just smoked a cigarette, smokers of one pack or more daily who had abstained for three hours, and nonsmokers.

All three groups achieved comparable speed and accuracy on a test in which participants had to scan rows and columns of letters in search of a single "target" letter (such as an "X" placed within an array of other letters). This test taps the visual recognition of letter features important for reading, Spilich notes.

Yet on a test of visual attention, in which volunteers monitored a set of 20 identical letters on a computer screen and pressed the space bar as soon as a similar-looking letter replaced one of the originals (say, a "B" turned into an "E"), nonsmokers reacted more quickly to the transformations than the other two groups. Those who had just smoked outperformed deprived smokers, perhaps because the latter group also experienced distracting withdrawal symptoms, Spilich says.

But on tests that placed more demands on memory, attention, and problem-solving skills, nonsmokers scored substantially higher than deprived smokers, who

in turn outscored "active" smokers. One such task required participants to watch as a set of up to six single-digit numbers flashed on a computer screen and then indicate whether a subsequently presented number had appeared in the set.

On a reading comprehension test, students were given a passage about a scientific dispute between Thomas Edison and George Westinghouse regarding the merits of direct electrical current versus alternating current and how their debate affected the first execution by electrocution in the United States. Both groups of smokers — especially those who had just smoked — exhibited not only poorer overall memory of the passage than nonsmokers, but also a greater likelihood of recalling peripheral, rather than critical, points in the text, the researchers report.

A final task required students to operate a computerized driving simulator (equipped with a steering wheel, gear shift with two forward gears, and a foot-operated gas pedal) in a road race that presented various obstacles, such as oil slicks and competing cars. Students fresh off a smoke had an average of 11 rear-end collisions in the approximately 4-minute race, compared with five for deprived smokers and two for nonsmokers.

Memory and judgment problems exhibited by smokers may reflect not only the physiological actions of nicotine in the brain, but also exposure to carbon monoxide in cigarette smoke, which lowers concentrations of oxygen in the blood, Spilich suggests.

Whether or not cigarette smoking makes people less alert behind the wheel, Spilich's data support evidence that a disproportionate number of smokers experience automobile and industrial accidents, a trend documented by several research teams and insurance companies.

Critics have charged that such findings leave open the question of whether other behaviors, such as increased alcohol consumption or drunk driving among smokers, cause the link between various accidents and cigarette use.

But in a study of 3,714 drivers recruited from a Massachusetts traffic safety

school and through that state's registry of motor vehicles, smokers had up to 50 percent more traffic accidents and 46 percent more traffic tickets than nonsmokers, even when researchers controlled statistically for group differences in alcohol consumption, age, driving experience, and education.

A propensity for risk-taking in general may make many smokers more accident-prone while driving, asserted physician Joseph R. DiFranza of the University of Massachusetts Medical Center in Fitchburg and his colleagues in the September 1986 *NEW YORK STATE JOURNAL OF MEDICINE*. Smokers as a group show more willingness to take health risks by not wearing seat belts and by avoiding regular medical and dental checkups, they noted.

"Spilich's study suggests that the cognitive function of smokers may contribute to traffic accidents as well," DiFranza says. "Our society tends to deny that nicotine is a drug and can have negative effects on thinking."

Based on studies conducted to date, DiFranza and his associates contend that smokers should pay more for automobile collision insurance and that nonsmokers should be preferentially hired as professional drivers.

Most laboratory studies of nicotine's effects have neglected driving performance and other real-life behaviors, opting instead for basic tasks that allow researchers to track the substance's actions more easily in the brain, maintains psychologist Herbert Weingartner of the National Institute of Mental Health in Bethesda, Md.

Spilich's report provides "tantalizing findings," he says, although future work needs to establish whether the thinking and memory capacities of smokers differ from those of nonsmokers prior to experimental challenges. It also remains unclear whether nonsmokers given some form of nicotine would read stories as poorly and drive as errantly as active smokers, Weingartner argues.

Other scientists take a much dimmer view of the claim that cigarettes may undermine complex thought. Numerous studies conducted in the past 10 years indicate that nicotine improves performance on some memory tasks and apparently boosts the ability to incorporate new information into memorable form, remarks psychologist David M. Warburton of the University of Reading in England.

For example, on a test requiring the identification of three odd or three even digits from a series of rapidly presented numbers, Warburton's group has charted

improvements among smokers immediately after smoking and among nonsmokers who consumed nicotine in gum or tablets. They have also found that both smokers and nonsmokers administered nicotine tablets perform the Stroop task (*SN*: 5/9/92, p.312) more quickly and accurately. This test requires participants to say aloud as rapidly as possible the contrasting ink colors in which a list of color words is printed (for example, to say "blue" in response to the word "yellow" printed in blue ink). The initial impulse is to read the words and ignore their ink colors.

Nicotine directly boosts memory as well as concentration, according to a study directed by Warburton and published in the September 1992 *PSYCHOPHARMACOLOGY*. Smokers took one drag on either a nicotine-rich or nicotine-free cigarette after studying each of eight four-word blocks of a word list. Immediately after the presentations, nicotine smokers displayed significantly greater memory than their counterparts for the later blocks. After a 10-minute delay, nicotine smokers remembered all the blocks better than the nicotine-deprived group.

Since volunteers did not begin to smoke until after viewing the first block, nicotine apparently enhanced the ability to form associations between those words during the delay period, Warburton asserts.

In a related study also appearing in the September 1992 *PSYCHOPHARMACOLOGY*, men who smoked low-nicotine cigarettes immediately after studying a list of word pairs remembered more of the list one week later than did men who either smoked nicotine-free cigarettes or did not smoke. A group of men who smoked medium-nicotine cigarettes performed worse at one week than low-nicotine smokers but better than the other participants, report psychologist Ian M. Colrain of the University of Auckland in New Zealand and his colleagues.

Nicotine administered through injections or tablets also spurs improvements in attention and awareness of one's surroundings among Alzheimer's disease patients, according to small pilot studies conducted by Warburton's group and a U.S. team that includes Weingartner. But these effects fall well short of sparking major progress in performing daily tasks or remembering routine information, the scientists say.

Warburton theorizes that nicotine enhances the transmission of the chemical messenger acetylcholine from the inner brain to the cortex, the outer brain layer where complex thought takes place. Brain-wave studies indicate that acetylcholine helps stabilize electrical activity in the cortex and foster more

efficient thinking about new information, Warburton proposes.

"I'm puzzled by Spilich's data," he adds.

In contrast, psychologist Neil E. Grunberg of the Uniformed Services University of the Health Sciences in Bethesda, Md., sees Spilich's study as complementing the work of Warburton and others.

Although future studies need to include broader samples and a wider array of tasks, it appears that nicotine boosts attention and memory only up to a point, says Grunberg, who edited a summary of research on nicotine's mental effects for the Surgeon General's 1988 report on smoking and health. Like many other addictive drugs, nicotine may interfere with thinking at relatively high doses and as tasks increase in complexity, he asserts.

Nicotine may exert its desirable mental effects within an "optimal dose range," Grunberg notes, as indicated by the low-nicotine cigarette advantage observed in Colrain's study. Even a couple of early reports by Warburton suggested that low to moderate nicotine doses may prove superior to higher doses in stimulating attention and memory, Grunberg points out.

He and his colleagues are now developing an animal model of nicotine's mental and physiological effects. They find that heightened attention to external stimuli, indicated by a more pronounced "startle" response to sudden loud noise, occurs among rats receiving constant daily doses of nicotine delivered through tiny pumps implanted under their skin. Rats given nicotine perform simple, previously learned tasks more quickly and accurately than nicotine-free controls, but they lag behind controls on complex tasks, Grunberg says.

Nicotine stimulates at least three different receptors on brain cells, he adds. If scientists unravel the function of these still poorly understood chemical gateways and pin down the optimal dose range for nicotine, it may be possible to design more effective drugs to treat a number of memory- and thought-sapping brain diseases, Grunberg suggests.

Meanwhile, Spilich plans to investigate complex thinking and memory among tobacco chewers and look for possible cognitive contrasts between men and women who smoke. In an earlier study, he and his co-workers uncovered "tentative" evidence of more severe short-term memory problems among male smokers, he says.

"I'm not a violent antismoker," Spilich remarks. "But we've run our experiments over and over, and we always get the same negative results for cigarette smokers on complex mental tasks." □