matics and Computer Science (CWI) in Amsterdam succeeded in factoring a monster 180-digit number belonging to a special set, called Cunningham numbers, that are easier than ordinary numbers to factor. After improving the software and the algorithm—called Number Field Sieve—used for pinpointing likely prime numbers, Te Riele's team, including researchers from CWI and from Microsoft and Sun Microsystems, devoted 5 months on 300 personal computers and a Cray 916 supercomputer to finding the two prime factors of a 155-digit number. "Our aim was to show that in principle this can be done," Te Riele says.

For the moment, he says there's little reason for European users to worry that someone will snoop on their Internet credit card purchases—cracking the code still takes too much computing firepower and expertise. He figures it won't be long, however, before such code-cracking becomes common enough to threaten ordinary users. "The situation can become unsafe in 2 or 3 years," he says.

One of the inventors of the RSA code says he had already reconciled himself to someone breaching the code. "I and fellow cryptographers have been recommending for a long time that keys of that size are too short," says Ronald Rivest, a cryptographer at the Massachusetts Institute of Technology. All Internet commerce, says Te Riele, may soon have to move to the more intractable codes—involving 232 digits—that are now standard in the United States or the even longer codes of 309 digits used for government and military transactions. At the current rate of progress, says Te Riele, even his group would not succeed at breaking such codes for at least another 25 years.

109417386415705274218097073220403576120037329454492059909138421314763499842889347847179972578912673324976257528997818337970765372440271467435315933543338975102639592829741105772054196573991675900716567808038066803341933521790711307779×106603488380168454820927220360012878679207958575989291522270608237193062808643

Choice multiple. A 155-digit number with its two prime factors, identified by Herman te Riele and his team.

CREDIT: CWI

–ALEXANDER HELLEMANS

Alexander Hellemans is a writer in Naples, Italy.

NEUROSCIENCE

Probing Alcoholism's 'Dark Side'

NEW ORLEANS—Alcoholics, it seems, may drink not just to feel good, but also to avoid feeling bad. At least that was the message delivered by new results on the brain chemistry of rats presented at the American Chemical Society meeting here last week by neuroscientist George Koob of The Scripps Research Institute in La Jolla, California. Work by his team shows that in animals, brain levels of a neurotransmitter associated with stress responses skyrocket during withdrawal from alcohol. The finding buttresses a long-standing view that addicts take their drug of choice as a form of self-medication to prevent depression and stress.

> **"When you're dependent, you're drinking to restore your brain's reward system to its normal balance."**
>
> **—George Koob**

Enoch Gordis, head of the National Institute on Alcohol Abuse and Alcoholism in Bethesda, Maryland, calls the finding "very important." Knowing that this stress neurotransmitter, a small protein called corticotropin-releasing factor (CRF), is involved in alcoholism may provide a new target, he says, for gene hunters who are looking for the genetic changes that make members of some families more susceptible to the condition than others. In addition, it could help pave the way for novel medications that combat the anxiety associated with alcohol withdrawal.

Over 15% of people who try alcohol wind up becoming addicted. But treating the disease has proved difficult because biochemically alcoholism is anything but simple. Alcohol affects several families of neurotransmitters, initially stimulating the release of dopamine in the amygdala and the nucleus accumbens, the brain's reward centers. The levels drop to normal with continued drinking, however, and medicines that target these centers—modulating the effects of dopamine—"have been something of a disappointment" in treating alcoholism, says Koob. That suggests that other factors are involved in dependence, leading the team to explore what Koob calls "alcoholism's dark side"—the reinforcement that alcohol could provide by eliminating the withdrawal symptoms of anxiety and depression.

In the mid-1990s, Koob and his colleagues—who include Floyd Bloom, editor-in-chief of *Science*—began focusing on CRF. The brain peptide works both through the pituitary gland and directly in the brain to trigger the release of hormones and other changes that spark arousal, vigilance, and mood changes. These responses are healthy when dealing with, say, an attacking predator, but over the long haul they can produce chronic anxiety—symptoms that are also linked to drug dependence. One study from Koob's group that looked at marijuana withdrawal showed that CRF levels jumped threefold when mice habituated to marijuana were injected with a compound that countered its effect (*Science*, 27 June 1997, p. 1967). Similarly, alcohol-dependent rats forced to go on the wagon show classic anxiety signs, such as avoiding unfamiliar places. And in one early study, when Koob and his colleagues injected CRF-blocking peptides into the rats' brains, they found that the stress responses fell dramatically.

So in the current study, Koob and his colleagues decided to take a closer look at CRF. Bert Weiss and other Scripps team members started by implanting tiny tubes in the brains of rats to allow them to monitor the concentrations of the peptide in the animals' cerebrospinal fluid over a period of weeks. They found that to start with, the levels were similar in both normal controls and alcohol-dependent rats, but when the dependent rats were forced to go on the wagon, their CRF levels shot up 10-fold. The researchers are currently studying what happens when they start drinking again. Koob says his team is not sure why CRF levels increase during abstinence, but it may be because alcohol suppresses another brain neurotransmitter called glutamate, which in turn is thought to spark the release of CRF, and once that suppression is gone, CRF levels soar.

But the rise in CRF apparently isn't the only brain neurotransmitter change underlying alcohol dependency. In another recent rat study, Koob and his colleagues showed that brain levels of the reward-inducing dopamine drop to half their normal amount during withdrawal and return to normal levels when alcohol-dependent rats drink. Together, the low dopamine and high CRF levels may provide a powerful stimulus to drink. "It's a double whammy," says Koob. "When you're dependent, you're drinking to restore your brain's reward system to its normal balance." That, he adds, could help explain why during their first year of treatment only about half of alcoholics are able to kick their drinking habits.

–ROBERT F. SERVICE