Bitter Truth: Humans, Chimps Developed Ability to Taste Toxic Compounds Through Separate Genetic Mutations

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Humans and chimpanzees share the ability to taste, or not taste, a bitter synthetic compound called PTC—as well as numerous other sour and toxic substances—but contrary to longstanding scientific thought, they developed that ability through separate genetic mutations, according to new research led by a University of Utah and University of Washington geneticists Stephen Wooding, Ph.D., and Michael Bamshad, M.D.

The ability to taste PTC (phenylthiocarbamide) and other bitter compounds probably evolved as a way to protect humans and chimpsanimals from eating poisonous plants, according to Stephen Wooding and Bamshad, Ph.D., senior lead authors of a study reported in the April 13 cover story in *Nature*. Being a PTC taster or non-taster has far-reaching implications for human behavior, such as in the foods people eat and even whether they smoke cigarettes, said Wooding, research assistant professor of human genetics at the U of U's Eccles Institute of Human Genetics.

Evidence that humans and chimpanzees harbor different kinds of mutations suggests that the similar patterns of PTC sensitivity in the two species may be an evolutionary coincidence. "With this particular gene, it probably shows that humans and chimps had vastly differentprobably faced different pressures fromof natural selection," he Wooding said. "Chimps and humans outwardly show the same patterns of variation, but it"s due to completely different genetic mutations in the two speciesthe

mutations in each species are affecting taste sensitivity in completely different ways.”

About 75 percent of people worldwide can taste PTC, while the remaining quarter can't. PTC tasters are less likely to smoke cigarettes than non-tasters, but they"re also less likely to eat cruciferous vegetables, such as broccoli, that are important sources of nutrition, Wooding said.

Differences in PTC sensitivity were first discovered in 1930, when American chemist Arthur Fox accidentally let loose some of the compound in his laboratory. Fox noted that while some people complained of a bad taste from PTC, others could not taste it all. After that, he conducted experiments and found that about 70 percent of people were PTC tasters.

Following a study of chimpanzees more than 65 years ago, sScientists thought the gene responsible for the ability to taste PTC evolved long before humans and chimps diverged into separate species. But after examining a mutation of the gene that actually reduces people's and chimps" sensitivity to PTCpatterns of variation at a molecular level, Wooding and Bamshad, along withnd other researchers collaborators at the German Institute for Human Nutrition, Arizona State University, and the Southwest Foundation for Biomedical Research, concluded the mutationat the "insensitive” form of the gene evolved separately in humans and chimps as part of natural selectionthrough completely different mutations.

People carry two functional forms of the PTC gene, one of which evolved over the last 1.5 million years or so—long after people and chimps had emerged as different species 7 to 10 million years ago. Although they're not sure why humans developed mutations of the gene that aren"t sensitive to PTC, Wooding, Bamshad, and their co-researchers theorize that people who can't taste the substance developed

sensitivity to a different, bitter compound, which might have provided an evolutionary advantage.

The researchers also conducted a taste test with 39 chimpanzees, to observe their sensitivity to PTC. Using a test similar to that used in many classrooms, in which children are asked to taste a piece of paper containing minute concentrations of PTC, they fed plain apples and apples soaked in small concentrations of PTC to the chimps. (PTC is not harmful and the chimps suffered no ill effects from eating it.) These results verified the same gene is responsible for the ability to taste or not taste PTC in both humans and chimps.

Comparisons of the taste test results with a gene sequence analysis showed that, like humans, chimps carry two forms of the PTC gene, but unlike the functional non-taster form that reduces PTC sensitivity humans, the one found in chimps is broken. After examining the molecular structure of the gene, Wooding and his fellow researchers pinpointed a mutation in a single nucleotide—one of the structural units of DNA—as the difference between the taster and non-taster forms found in chimps. A single nucleotide"s difference indicates the mutation occurred long after humans and chimps diverged, Wooding said.

Evidence that chimpanzees have a "broken” form of the gene indicates that taste likely was diminished in chimps for different reasons than in humans. Wooding and Bamshad theorize chimps lost some PTC sensitivity as a result of plants disappearing and their diets being altered over eons, so that they were no longer pressured to taste the poisons found in those plants. But it also could be from a change in chimp behavior, such as a change in diet choice, Wooding said.

"Different mutations in humans and chimps might have emerged for different reasons,” he said, “but in both cases we think what’s driving it is the need to eat avoid toxins found in plants, which are common in

primate diets."

The PTC gene is one of about 30 known to produce sensitivity to bitter tastes. A national group of U.S. researchers, including Mark F. Leppeart, Ph.D., professor and co-chair of the U's Department of Human Genetics and Hillary Coon, Ph.D, research associate professor of psychiatry, discovered the PTC gene in 2002. If scientists can unravel the nature of sensitivity to PTC and other bitter chemicals, they may be able to produce compounds with important ramifications for human nutrition and diet, according to Wooding and Bamshad.

"Ultimately, we'd like to connect the patterns of variation in genes to human behavior," Wooding said.

Source: University of Utah

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