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Color blindness cured in monkeys

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The natural habitat of the squirrel monkey is the rainforest canopy. This is a young male in the Brazilian Amazon. All male squirrel monkeys are red-green colour blind but the majority of females have trichromatic colour vision. Image: Neitz Laboratory

(PhysOrg.com) -- Researchers from the University of Washington and the University of Florida used gene therapy to cure two squirrel monkeys of color blindness — the most common genetic disorder in people.

Writing online Wednesday in the journal *Nature,* scientists cast a rosy light on the potential for gene therapy to treat adult vision disorders involving cone cells — the most important cells for vision in people.

"We've added red sensitivity to cone cells in animals that are born with a condition that is exactly like human color blindness," said William W. Hauswirth, Ph.D., a professor of ophthalmic molecular genetics at the UF College of Medicine and a member of the UF Genetics Institute and the Powell Gene Therapy Center. "Although color blindness is only moderately life-altering, we've shown we can cure a cone disease in a primate, and that it can be done very safely. That's extremely encouraging for the development of therapies for human cone diseases that really are blinding."

The finding is also likely to intrigue millions of people around the world who are colorblind, including about 3.5 million people in the United States, more than 13 million in India and more than 16 million in China. The problem mostly affects men, leaving about 8 percent of Caucasian men in the United States incapable of discerning red and green hues that are important for everyday things like recognizing traffic lights.

"People who are colorblind feel that they are missing out," said Jay Neitz, Ph.D., a professor of ophthalmology at the University of Washington. "If we could find a way to do this with complete safety in human eyes, as we did with monkeys, I think there would be a lot of people who would want it. Beyond that, we hope this technology will be useful in correcting lots of different vision disorders."

The discovery comes about 10 years after Neitz and his wife Maureen Neitz, Ph.D., a professor of ophthalmology at the University of Washington and senior author of the study, began training two squirrel monkeys named Dalton and Sam.

In addition to teaching the animals, the Neitz research group worked with the makers of a standard vision-testing technique called the Cambridge Colour Test to perfect a way the monkeys could "tell" them which colors they were seeing.

The tests are similar to ones given to elementary children the world over, in which students are asked to identify a specific pattern of colored dots among a field of dots that vary in size, color and intensity. The researchers devised a computer touch screen the monkeys could use to trace the color patterns. When the animals chose correctly, they received a reward of grape juice.

Fruit market on the Amazon, near the natural habitat of the squirrel monkey. The image on the left was digitally altered to simulate how the scene would look to a color blind monkey (or person). Image: Neitz Laboratory

Likewise, decades were spent by Hauswirth and colleagues at the University of Florida to develop the gene-transfer technique that uses a harmless adeno-associated virus to deliver corrective genes to produce a desired protein.

In this case, researchers wanted to produce a substance called long-wavelength opsin in the retinas of the monkeys. This particular form of opsin is a colorless protein that works in the retina to make pigments that are sensitive to red and green.

"We used human DNAs, so we won't have to switch to human genes as we move toward clinical treatments," said Hauswirth, who is also involved in a clinical trial with human patients to test gene therapy for the treatment of Leber congenital amaurosis, a form of blindness that strikes children.

About five weeks after the treatment, the monkeys began to acquire color vision, almost as if it occurred overnight.

"Nothing happened for the first 20 weeks," Neitz said. "But we knew right away when it began to work. It was if they woke up and saw these new colors. The treated animals unquestionably responded to colors that had been invisible to them."

It took more than a year and a half to test the monkeys' ability to discern 16 hues, with some of the hues varying as much as 11-fold in intensity.

Dalton is named for John Dalton, an English chemist who realized he was colorblind and published the first paper about the condition in 1798.

"We've had Dalton and Sam for 10 years. They are like our children," Neitz said. "This species are friendly, docile monkeys that we just love. We think it is useful to continue to follow them — it's been two years now that they've been seeing in color, and continuing to check their vision and allowing them to play with the computer is part of their enrichment."

With the discovery, the researchers are the first to address a vision disorder in primates in which all photoreceptors are intact and healthy, providing a hint of gene therapy's full potential to restore vision.

About 1 in 30,000 Americans have a hereditary form of blindness called achromatopsia, which causes nearly complete color blindness and extremely poor central vision. "Those patients would be targets for almost exactly the same treatment," Hauswirth said.

Even in common types of blindness such as age-related macular degeneration and diabetic retinopathy, vision could potentially be rescued by targeting cone cells, he said.

"The major thrust of the study is you can ameliorate if not cure color blindness with gene therapy," said Gerald H. Jacobs, Ph.D., a research professor of psychology at the University of California, Santa Barbara, who was not involved in the research. "There are still questions about safety, but in these monkeys at least, there were no untoward effects. Those who are motivated to ameliorate their color defect might take some hope from the findings.

"This is also another example of how utterly plastic the visual system is to change," Jacobs said. "The nervous system can extract information from alterations to photopigments and make use of it almost instantaneously."

Source: University of Florida (news : web)

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