Researchers have used gene therapy to restore colour vision in two adult monkeys that have been unable to distinguish between red and green hues since birth — raising the hope of curing colour blindness and other visual disorders in humans.

“This is a truly amazing study,” says András Komáromy, a vision researcher and veterinary ophthalmologist at the University of Pennsylvania in Philadelphia, who was not involved in the research. “If we can target gene expression specifically to cones [in humans] then this has a tremendous implication.”

About 1 in 12 men lack either the red- or the green-sensitive photoreceptor proteins that are normally present in the colour-sensing cells, or cones, of the retina, and so have red–green colour blindness. A similar condition affects all male squirrel monkeys (Saimiri sciureus), which naturally see the world in just two tones. The colour blindness in the monkeys arises because full colour vision requires two versions of the opsin gene, which is carried on the X chromosome. One version codes for a red-detecting photoreceptor, the other for a green-detecting photoreceptor. As male monkeys have only one X chromosome, they carry only one version of the gene and are inevitably red–green colour blind. A similar deficiency accounts for the most common form of dichromatic color blindness in humans. Fewer female monkeys suffer from the condition as they have two X chromosomes, and often carry both versions of the opsin gene.

“Here is an animal that is a perfect model for the human condition,” says Jay Neitz of the University of Washington in Seattle, a member of the team that carried out the experiment. Neitz and his colleagues introduced the human form of the red-detecting opsin gene into a viral vector, and injected the virus behind the retina of two male squirrel monkeys — one named Dalton in honour of the British chemist, John Dalton, who was the first to describe his own colour blindness in 1794, and the other named Sam. The researchers then assessed the monkeys’ ability to find coloured patches of dots on a background of grey dots by training them to touch coloured patches on a screen with their heads, and then rewarding them with grape juice. The test is a modified version of the standard ‘Cambridge Colour Test’ where people must identify numbers or other specific patterns in a field of coloured dots.

Colour coded

After 20 weeks, the monkeys’ colour skills improved dramatically, indicating that Dalton and Sam had acquired the ability to see in three shades (see video). Both monkeys have retained this skill for more than two years with no apparent side effects, the researchers report in Nature.

Adding the missing gene was sufficient to restore full colour vision without further rewiring of the brain even though the monkeys had been colour blind since birth. “There is this plasticity still in the brain and it is possible to treat cone defects with gene therapy,” says Alexander Smith, a molecular biologist and vision researcher at University College London, who did not contribute to the study.

“It doesn’t seem like new neural connections have to be formed,” says Komáromy. “You can add an additional cone opsin pigment and the neural circuitry and visual pathways can deal with it.”

Three human gene therapy trials are currently under way for loss of sight due to serious degeneration of the retina. These phase I safety studies injected a similar type of virus vector (but carrying a different gene) behind the retina as in the monkeys, and people treated have shown no serious adverse effects more than a year after, with some participants reporting marked
improvements in vision\textsuperscript{2}. These first human trials — which repair rods, a different type of photoreceptor cell — can be seen as a safety benchmark for any future treatment of cone diseases and colour blindness in humans, says Neitz.

"The biggest issue is that people who are colour blind have very good vision," Neitz says. "So before people are going to want to treat colour blindness you're going to want to ensure that this is completely safe, and that's going to take some work."

References


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I really hope journalists don't start yaking about treating embryos with viri... but who am I kidding. It'll be all over the news. "Gene therapy for your baby? The future is here, thanks to researchers at UW..."

Posted by: Alex Cranson | 17 Sep, 2009

I think this is wonderful!
The more we know about our bodies and our world, the better.
Where can we sign up as volunteers?

Posted by: Amy Day | 18 Sep, 2009

Brave New World, here we come.. good.

Posted by: alex palumbo | 18 Sep, 2009

At last, a gene therapy approach that actually works!

Posted by: William Colledge | 18 Sep, 2009

I found this article so encouraging in its implications for gene therapy concerning other eye diseases. I would like to think there will be similar trials in the UK.

Posted by: Barbara Moody | 18 Sep, 2009

In the abstract, the authors cite the pioneering work of Nobel Prize-laureates Wiesel and Hubel on the plasticity of ocular dominance in the visual system. Primary visual cortex consists of interdigitated domains in which neurons respond mainly to input from one eye. Hubel and Wiesel observed that the manipulation of visual input during postnatal development altered these domains. That is, the occlusion of one eye shortly after birth led to the enlargement of the other eye's domain into the deprived territory. The effect could be reversed, if the eye occlusion was reversed within a critical period. Much research ensued to uncover the underlying mechanisms.

Compared with monocular deprivation, color-blindness seems to pose a minor challenge to the visual system. In the present study, the neural circuitry necessary for color discrimination may have already been in place at the time of the intervention. Existing connections may have only needed to strengthen to attune the neurons to the novel inputs, precipitating the monkeys' correct decision. In this light, it is surprising that it took the monkeys five months to learn the new skill.

To better understand the neural mechanisms involved in the monkeys' improved color discrimination, it is crucial to find out precisely when after the intervention the photoreceptors become sensitive to new wavelengths.

Regardless, the findings of this study constitute a powerful prove of concept for the possibilities of gene therapy. In respect to plasticity, however, I wish...
we were more like salamanders.

Read more here:

Posted by: Peter Melzer | 18 Sep, 2009

it is an interestingly new information

sureshbabu

Posted by: suresh babu | 19 Sep, 2009

I think this is very interesting.
One wonders if the same process could be used to transplant colour genes that give infra red vision to some animals, into the human eye, and what such "colours" would appear like.

Posted by: Damien Murray | 20 Sep, 2009

I think that this way to monkey is not suit for people.

Posted by: Davin Ren | 21 Sep, 2009

It is interesting to note that gene therapy works for red-green color blindness in monkeys without any side effects. To start with, Similar trials may be carried out on humans to cure their red-green color blindness and slowly with more vigor to other diseases affecting humans.

Posted by: Govindareddy Ponnaluru | 23 Sep, 2009

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