Personalized Improvement of Color Perception in People with Red-Green Color Deficit

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Biotech & Life Science

Abstract

USU researchers have developed a customizable, novel eye contact lens inspired by the reflective, sub-micron spaced lamellae in the eyes of elephantnose fish. This innovation improves color perception in people with red-green color deficit while maintaining perceived hue, intensity, and lightness.

Problem

People with red-green color vision deficit (CVD) experience reduced quality of life and difficulty performing everyday tasks. Existing treatments distort perceived hue, chroma, lightness, and color naming.

Solution

Inspired by elephantnose fish, this technology uses optical nodes in a grid formation designed through color appearance models to optimize node composition, geometry, and arrangement for improved red-green vision.

Value Proposition

This personalized contact lens improves color perception, safety, and well-being while reducing costs, material use, and energy demand through efficient and customizable design.

Benefit

Twelve million people in the U.S. and 300 million people globally struggle with red-green color vision deficit (CVD). Their health, emotions and careers are negatively impacted leading to a decreased quality of life. Daily tasks such as driving, preparing food, or taking medications may be difficult. While typically inherited, color vision deficiency (CVD) frequently accompanies glaucoma, macular degeneration, Alzheimer’s disease, Parkinson’s disease, multiple sclerosis, and other diseases. Color vision deteriorates markedly with age. Clinical tests report that tinted lenses marketed to treat CVD increase contrast in some colors but decrease it in others and distort perceived hue, chroma (intensity), lightness, and color naming. Benefits of tinted contact lenses are offset by reduced acuity, depth and motion perception. Individual variation in severity further inhibits accommodation by such lenses. Commercial tinted (dye-doped) lenses and researched particle-doped lenses are optically limited by dependence on lens thickness and dopant content which induces aggregation and leaching.

USU Researchers took cues from nature by analyzing the eyes of elephantnose fish (Gnathonemus petersii), which have submicron sized crystal lamellae that contribute to their high acuity red-green color vision. Following this lead, researchers used optical nodes in regular formations on the contact lens that remedy perceived color difference and discriminability in persons who suffer from deuteranomaly. Through specific clinically tested models and simulations that identify optimal node composition, geometry, and arrangement, this technology provides an effective remedy with minimal side effects.

The optical node arrangements of each lens are customizable to provide personalization for each individual. Color appearance models indicate node-

decorated contact lenses offer minimal distortion of perceived hue, intensity, and lightness as well as improvement in perceived color difference and color discriminability. The customizability of the lenses also allows each to be made only with the needed materials, reducing waste. Self-assembly of nodes uses biocompatible materials at ambient conditions, offering safety and reduced demand for energy and materials. Researchers expect an expeditious path through future toxicity and clinical testing for rapid regulatory approval.

Market Application

This technology may be applied in the contact lens manufacturing market.

Inventors

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Publications

- Roper, Keith D., “Designing Gold Nanoparticles to Enhance Colorimetric Perception in Biomedicine,” InTechOpen, Biotechnology – Biosensors, Biomaterials, and Tissue Engineering, Annual Vol. 2024, 20 pp. DOI: http://dx.doi.org/10.5772/intechopen.14859

Intellectual Property

U.S. Non-Provisional Patent Application entitled "Lens, Method, and Apparatus for Alteration of Color Perception and Discriminability," Published December 26, 2024, No. US2024/0427175A1.

U.S. Continuation-in-Part Patent Application entitled "Transfer of Nanoparticles to a Substrate," Published May 1, 2025, No. US2025/0136773A1.