

# Architectural engineering professor leads study on perceptions of LED lighting

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A research team led by Kevin Houser, professor of architectural engineering, has determined that color and whiteness rendition has a profound effect on LED light source preference. The team's findings were published in *Lighting Research & Technology* in an article titled "Perceptual responses to LED illumination with colour rendering indices of 85 and 97".

In addition to Houser, the research team included architectural engineering graduate student Minchen Wei, and Aurelien David and Mike Krames from Soraa, the California-based lighting manufacturer that participated in the study.

The researchers recruited 48 participants to compare colorful and white objects under two different light-emitting diode (LED) sources: a blue-pumped LED with a two-phosphor mix and color rendering index (CRI) of 85 and a violet-pumped LED with three phosphors and a CRI of 97 (Soraa's VP3 Technology). CRI is a measure of a [light source](#)'s ability to show object colors realistically or naturally compared to a familiar reference source, either incandescent light or daylight. CRI has a maximum value of 100, with a lower value indicating that some colors may appear unnatural when illuminated by the lamp. For instance, incandescent lamps have a CRI above 99 while most fluorescent lamps have CRI values in the low to mid 80s. Additionally important for red color rendering, including human skin tones, is the index R9. Like CRI, R9 has a maximum value of 100. Incandescent lamps have R9 above 99 while fluorescent lamps vary widely (e.g., R9 of less than 0 to greater

than 90). The experimental set up achieved an R9 of 89 for the 97 CRI lamp and 24 for the 85 CRI lamp.

The team found that the participants strongly preferred colors under the light with the high CRI and R9. While this was anticipated, even more pronounced was the perception of common white objects. The strong preference for whites was made possible by the full visible spectrum of the high CRI sources, which is unlike standard LEDs that lack the short wavelengths, specifically violet.

Houser explained that the results have implications that consumers can see on a day-to-day basis. "We evaluate color continuously, sometimes consciously and sometimes not. I was recently in the produce section of a remodeled grocery store and most types of fruits looked unappealing. Then, I looked up to see that the store had converted the produce lighting to LEDs with apparently a low CRI. The color distortion that I was seeing was caused by the light sources."

He said the same concept applies to buying paint for a room in your house or a tie to match a shirt. "Lighting, more specifically the way objects appear under a light, makes a difference in how we perceive and evaluate the colors in our world."

Houser added that partnering with industry to conduct these types of studies is a win-win for both entities. "Soraa partnered with Penn State in cutting-edge research and in return we have provided data that Soraa can use to enhance their products."

"Kevin's depth of expertise and attention to detail have helped us breakdown the critical elements of lighting perception and develop fundamentally better products based on scientific facts, rather than on gimmicks or marketing tricks," said Mike Krames, Soraa of CTO. "We look forward to even more opportunities in understanding and improving

the way our customers view the world."

Soraa and Penn State have collaborated on similar lighting research since 2012. This present study builds upon findings that were released in January 2014 in a paper titled "Whiteness Perception Under LED Illumination."

**More information:** Perceptual responses to LED illumination with colour rendering indices of 85 and 97, *Lighting Research & Technology*, Published online before print August 22, 2014, [DOI: 10.1177/1477153514548089](https://doi.org/10.1177/1477153514548089)

"Whiteness Perception under LED Illumination." *LEUKOS: The Journal of the Illuminating Engineering Society of North America* Volume 10, Issue 3, 2014 [DOI: 10.1080/15502724.2014.902750](https://doi.org/10.1080/15502724.2014.902750)

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