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UTC Spotlight

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Maximizing Pedestrians' Perceptions of Safety Using Light Source Spectrum

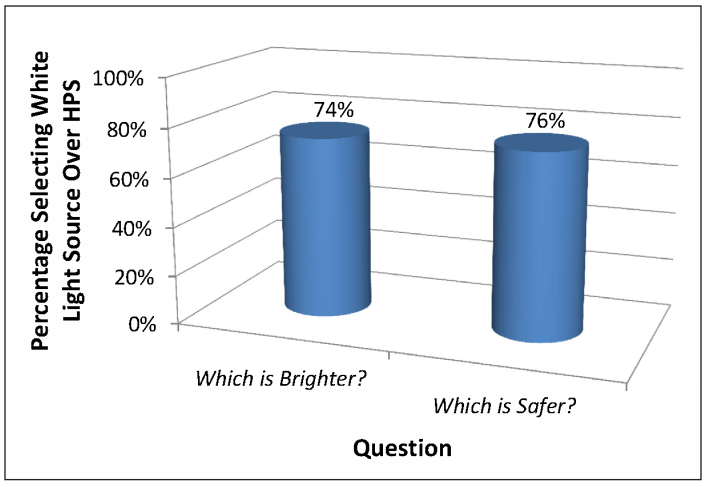
Lighting Research Center, Rensselaer Polytechnic Institute

When the same street was illuminated with conventional lighting (left) using high pressure sodium lamps, which produce yellowish light, and then with a white light source (right), residents perceived the latter as brighter even though the measured light level was substantially lower.

Traditionally roadway infrastructure is developed with traffic safety and efficiency in mind, but recognition of the importance of pedestrian needs has been growing. The benefits of roadway lighting systems in reducing crashes is well known. But it is becoming increasingly apparent that lighting can also impact the safety perceptions of pedestrians and their subsequent use of roadway systems. This can have implications for urban and suburban locations where pedestrian use is an important design consideration for roadside infrastructure.

Roadway lighting in the United States uses 51 billion kilowatt-hours per year, according to the Department of Energy. Most lighted roads in the United States and, by extension, the sidewalks adjacent to them are illuminated using high pressure sodium (HPS) lamps. These lamps produce light that has a yellowish appearance. By comparison, technologies such as light emitting diodes (LEDs) produce light that appears white.

At light levels typical for roadway and walkway lighting, the human visual system exhibits increased short-wavelength ("blue" light) sensitivity. As a consequence, an urban environment illuminated by white LEDs will appear brighter than the same location lit by yellowish HPS lamps even if the light levels, as measured by light meters, are the same.



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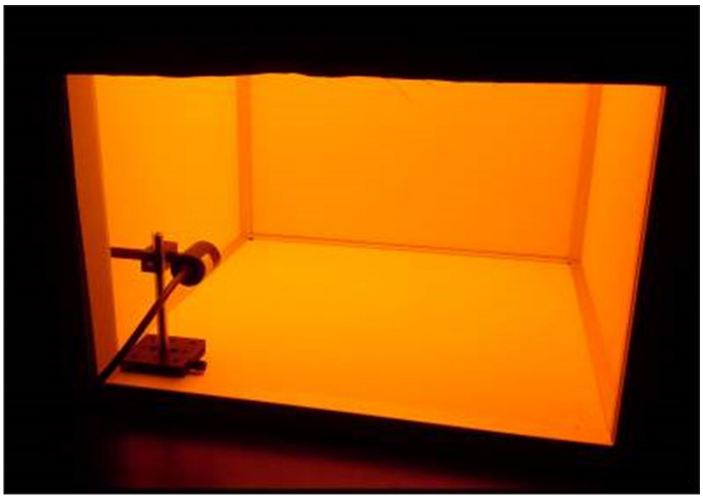
In a different experiment, most observers judged a street scene as brighter, safer, and more secure, under a white light source than under HPS, for the same measured light level.

This finding might be only of academic interest if it weren't for the fact that pedestrians' perceptions of their safety and personal security in an area illuminated by roadway lighting are directly related to how bright that area appears, and not to the measured light level. As a result, outdoor locations

illuminated by white LEDs will be perceived as safer and more secure than locations illuminated to the same light level by HPS lamps. Consequently, the light levels under LED roadway lighting installations could be reduced, with proportional reductions in electricity use, while maintaining perceptions of safety and security similar to those found under HPS roadway lighting systems.



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Human factors studies included laboratory investigations using light sources with different spectral properties.

As part of its study for the Region 2 University Transportation Research Center (UTRC) at the City University of New York, the Lighting Research Center (LRC) at Rensselaer Polytechnic Institute conducted human factors studies to investigate responses to light sources having different spectral (color) compositions and to develop a model to predict perceptions of brightness and, therefore, of safety and security under roadway lighting conditions.

The model includes inputs from recently discovered visual mechanisms that also influence the eye's pupil size and circadian responses to light, tying these scientific discoveries to practical lighting engineering recommendations. The model can be used to support the definition of benefit metrics for the specification of roadway lighting that would allow lighting engineers to better address the visual needs of pedestrians at night by taking into account both the spectrum of the light source and the measured light level to be used.

Using these benefit metrics, it is estimated that using white LEDs in roadway lighting systems could yield energy savings of more than 30 percent compared to using HPS lamps, potentially saving billions of kilowatt-hours of electrical energy annually, with associated environmental impacts in terms of reduced greenhouse gas emissions and light pollution. Such findings can have important significance for downtowns and other locations where encouraging pedestrian use is a key objective.

About This Project

The principal investigator for this project, *Leveraging Brightness from Transportation Lighting Systems*, was John D. Bullough, Ph.D., senior research scientist at the Lighting Research Center (LRC), Rensselaer Polytechnic Institute. Graduate research assistant Ute C. Besenecker, M.S., research scientist Leora C. Radetsky, M.S., and LRC director Mark S. Rea, Ph.D. also collaborated on the project. The study was sponsored by the Region 2 University Transportation Research Center under the direction of Camille Kamga, Ph.D., director, and Penny Eickemeyer, MCRP, associate director for research. Additional industry support was provided by members of the Transportation Lighting Alliance (Audi, Automotive Lighting, Hella, OSRAM SYLVANIA, Philips Lighting, and Varroc Lighting).
http://www.utrc2.org/research/projects/leveraging-brightness-transportation-lighting-systems