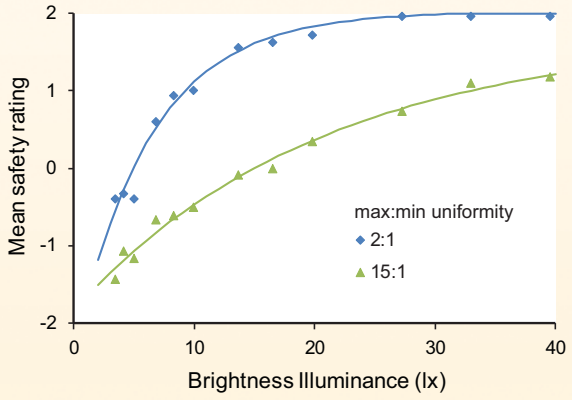
Perceived Safety as a Function of Light Level, Uniformity, and Spectrum

Parking lot lighting must provide: (1) good visual performance for navigating and avoiding vehicle conflicts and tripping hazards and (2) a personal sense of safety and security for occupants, primarily related to detecting and identifying people, and judging their actions.

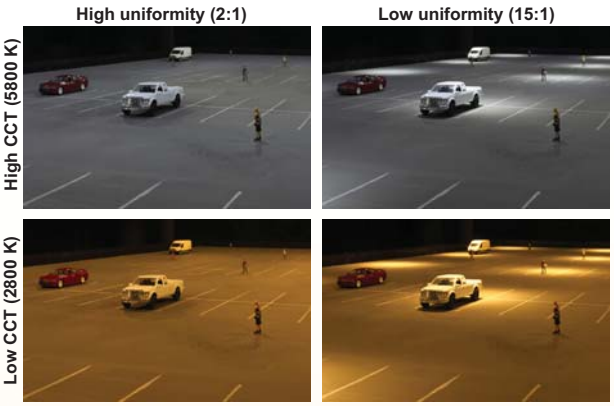
Visual performance is well described by the established Relative Visual Performance (RVP) metric. In contrast, the current understanding of the effects of lighting on perceptions of safety and security has been more piecemeal; previous studies by the LRC have related perceptions of safety to average illuminance, spectrum, and uniformity. The study used a laboratory parking lot mockup to create mathematical equations that predict brightness and safety perceptions based on all three of these variables:

$$\text{Brightness} = 14.2 \log E + 6.73 \log C - 6 \log U - 21.6$$
$$\text{Safety} = 2.58 \log E + 0.778 \log C - 1.36 \log U - 3.49$$

Where:
E is average illuminance (lx)
C is CCT (K)
U is uniformity (max:min illuminance)



The average illuminance and CCT of the conditions in the study could be defined in terms of spectrally weighted brightness illuminance, previously determined by the LRC to account for the tendency to judge higher CCTs as brighter even when matched for average illuminance.



Study participants rated the brightness and safety of each scene they were shown with various CCT levels and uniformity ratios.

A Lighting Research Center student with the parking lot mockup designed for the study.

All three independent variables — average illuminance, spectrum, and uniformity — had statistically significant effects on the brightness and safety ratings. The study results also match those from previous LRC experiments that were conducted outdoors, showing that the participants judged the laboratory mockup similarly to how they would judge an actual outdoor parking lot. The results of this study can be used to design parking lot lighting to minimize energy use while providing a desired sense of safety for occupants.

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Lighting Research Center, Rensselaer Polytechnic Institute • 21 Union Street • Troy, NY 12180 • (518) 687-7100 • www.lrc.rpi.edu