Where Are the Products?

by Mariana Figueiro

Our collective obsession with one metric—illuminance—has discouraged manufacturers from developing new lighting systems. A different approach can open up possibilities for better health

Mark Rea, in his recent essay (*LD+A*, February), discussed the value of lighting and how the lighting industry is more focused on cost reduction and less on delivering the benefits that lighting can bring to the equation. The non-visual benefits of light on human health are real and multifaceted, but remain largely unrealized because there are few lighting products designed to deliver those benefits. Hopefully, how lighting is designed, manufactured and applied in living and working environments will change in the near future.

The benefits of delivering lighting that helps us sleep, improves our mood, reduces depression, or makes us feel more alert on the job are, simply put, priceless. What parent of an autistic child wouldn't pay a premium to have a lighting system at home and in school that would reduce the need for a sleeping-aid pill that their child is taking? What family wouldn't spend money on a new table lamp to help their loved grandparent stay at home longer, rather than move them to a more controlled institution? What employer wouldn't upgrade their lighting system if they knew it would increase alertness and wellbeing in the work environment? And what facility manager wouldn't invest in installing nightlighting that could reduce risk of falls in assisted living facilities or nursing homes? But where are the products? Even if we did an educational campaign and convinced various stakeholders that lighting could benefit them, they would not be able to take their credit card out and purchase that lighting system that was designed to improve human health and wellbeing.

ENOUGH TO ACT ON

True enough, we don't know everything about light's effect on health and wellbeing, and we don't have an "approved" spectral efficiency function that represents the non-visual effects of light on humans. But we know enough to apply light differently than we do now to shape our physiology and neural activity. Current research is mature enough to indicate that we could deliver light to increase or decrease melatonin and cortisol production, in order to increase or decrease alertness, and perhaps performance. As Rea pointed out, V(λ)represents the spectral sensitivity of only one of several neural channels affecting vision and is not representative of any non-visual response to light. Nevertheless, our collective obsession with photopic lumens per watt or per sq ft (illuminance) has functionally limited manufacturers from developing new lighting systems.

Researchers backed away from establishing spectral weighting functions that might be used to characterize light stimuli for a variety of non-visual responses. There are difficulties associated with establishing additive, one-dimensional units to quantify the non-linear responses of physiological and neurological systems to retinal light exposure. This is to be expected, as each measurable visual and non-visual response reflects the temporal, spatial, spectral and absolute response characteristics of a different neural channel. But this complexity should not stop progress.

Toward that progress, the German Institute for Standardization released a prestandard, DIN V 5031-100, defining an action spectrum for nocturnal melatonin suppression ($S_{ms}(\lambda)$) lumen, using

the empirical Gall function, c(λ). This gets us much closer to helping manufacturers develop new products. Rea and colleagues proposed a model of human circadian phototransduction that gets us even closer because predictions can be made, taking into account both the spectral and absolute sensitivities of the circadian system. Thus, the model can be used to estimate the effectiveness of any light source at any light level. Yes, it's complicated, but a simpler set of guidelines based on the model would at least be useful to rank the order of the effectiveness of various lights and levels for stimulating the circadian system, and, most importantly, for developing new products.

LOW-HANGING FRUIT

New models will and certainly should be developed for other non-visual functions. However, rather than wait until researchers and standard-setting bodies agree on something (i.e., anything!), which might take a very long time, let's get started on developing new products based upon the existing science. In my view, the "low-hanging fruit"—where we have the best evidence of success—is in lighting applications for older adults.

Right now, we can develop products and applications to improve the life of older adults through the 24-hour lighting scheme we recently proposed. Because sleep and falls are the two major issues associated with aging, this lighting scheme calls for the use of lighting systems that meet the needs of the aging visual system, deliver high circadian stimulation during the daytime and low circadian stimulation in the evening, and use nightlights that are designed to reduce falls.

Manufacturers are now promoting dynamic lighting systems to increase circadian stimulation during the daytime, but calculations using the mathematical model by Rea and colleagues showed that, for the same light level, circadian stimulus will be no more than a factor of 2 greater when changing correlated color temperature of the light from 2,700K to 6,500K. Changing light levels, on the other hand, is what increases (or

decreases) circadian stimulation. For example, our calculations show that for warm white light, circadian stimulus drops by a factor of 4 when the distance from the source increases from 1 to 4 ft. Changing both light level and spectrum would be a more effective solution, as proposed in our 24-hour lighting scheme. The key message is that manufacturers can rely on existing science to help them develop the products that will deliver most of the benefit.

Another example is falls risks. The interaction between the visual and the perceptual systems is well known, and the importance of lighting for helping people orient in a space is obvious. The laboratory studies we performed clearly showed that perceptual cues, provided by the addition of horizontal/vertical nightlights in the environment, help maintain balance when older adults stand and navigate in a dimly-lit space. The use of horizontal/vertical nightlights that provide perceptual cues to help maintain postural control and stability is a clear example of the value that lighting applications can bring.

But again, we need products and should not have to wait for another standard to be set before we start using these valuable lighting solutions to help older adults live better. So let's begin to talk about how we can bring research into practice to help raise the value of lighting. Let's stop our race to the bottom, where we only maintain the lowest lighting product cost! Let's strive to race to the top and find the most valuable lighting solutions! The benefits to the end users will be much greater than what they are currently getting from lighting solutions that are merely meeting the current lighting standards.

Mariana Figueiro, Fellow IES, is light and health program director at the Lighting Research Center (LRC) and associate professor at Rensselaer Polytechnic Institute. She led the LRC Light and Health Institute, May 6-7, where lighting and healthcare professionals learned to utilize light to benefit human health and wellbeing.