

Tuning the Light in Senior Care



DOE SSL Healthcare Lighting Webinar Series

October 18, 2016

GATEWAY
Demonstrations



SMUD


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GATEWAY

Demonstrations



Tunable LED Systems

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency &
Renewable Energy

CALiPER

Report 23:

Photometric Testing of White-Tunable LED
Luminaires

August 2015
Addendum January 2016

Prepared for:
Solid-State Lighting Program
Building Technologies Office
Office of Energy Efficiency and
Renewable Energy
U.S. Department of Energy

Prepared by:
Pacific Northwest National
Laboratory

● UNDERSTANDING
LED Color-Tunable Products

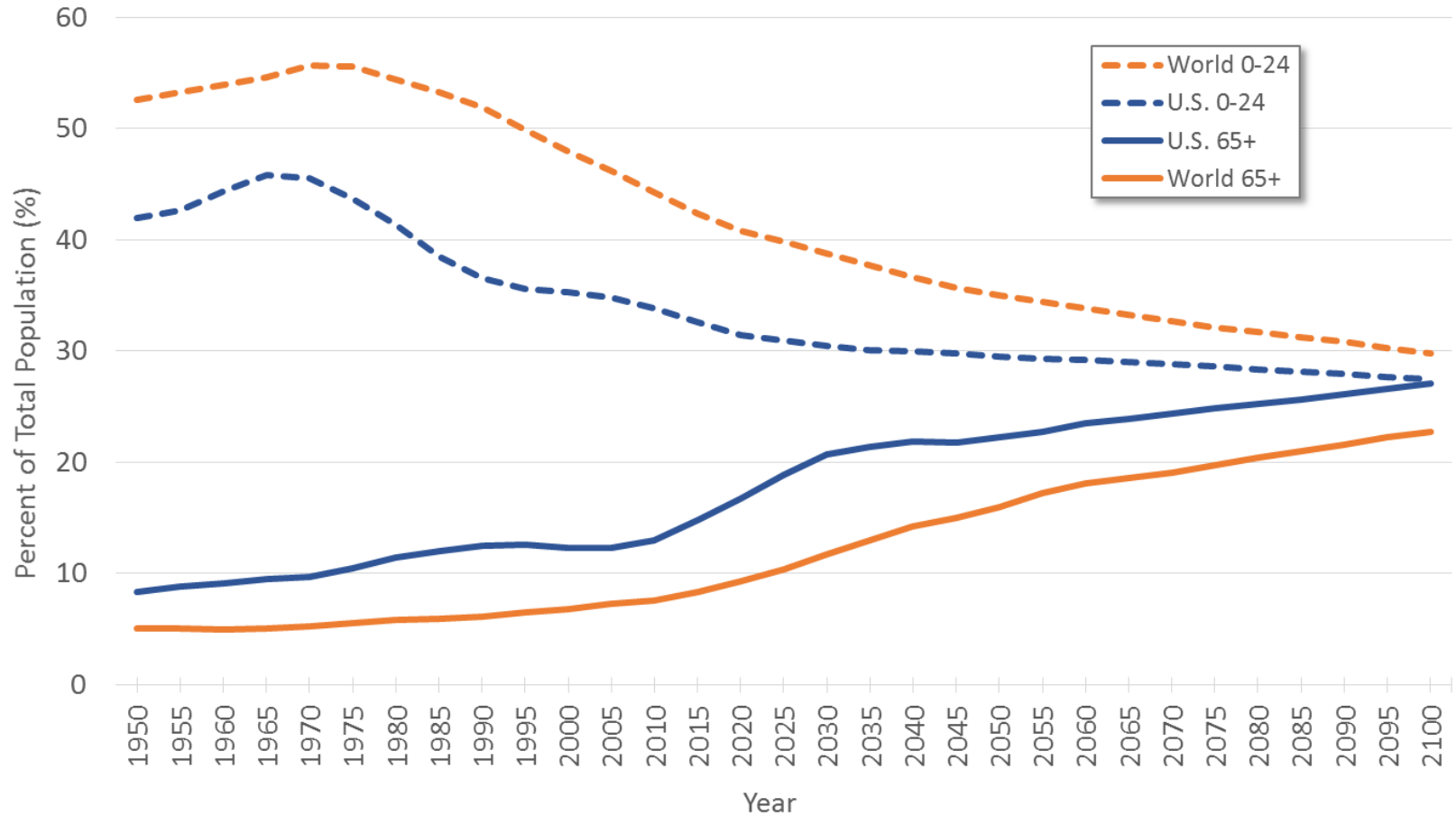
● SPECIFYING
LED Color-Tunable Products

● CONTROLLING
LED Color-Tunable Products

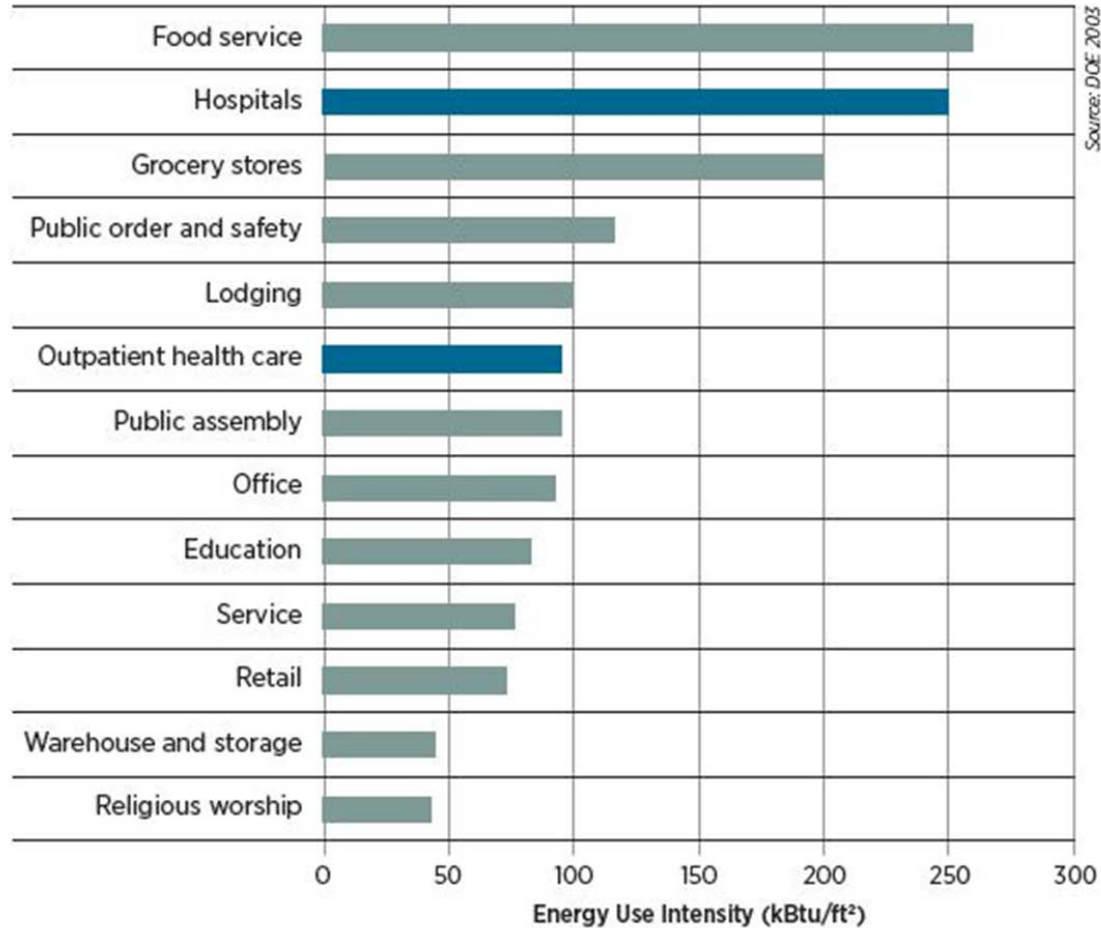
● TESTING
LED Color-Tunable Products

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency &
Renewable Energy

0-24 and 65+ as a Percent of the Global and US Population



Energy Use Intensity



Source: DOE, 2003

*Advanced Energy
Retrofit Guide:
Healthcare Facilities,
US DOE, Sept 2013*

DOE Healthcare Webinar Series

The Nurses' Perspective on Hospital Patient Room Lighting

Sept 13, 2016 Robert Davis & Andrea Wilkerson, PNNL
Pat Lydon, Legacy Health

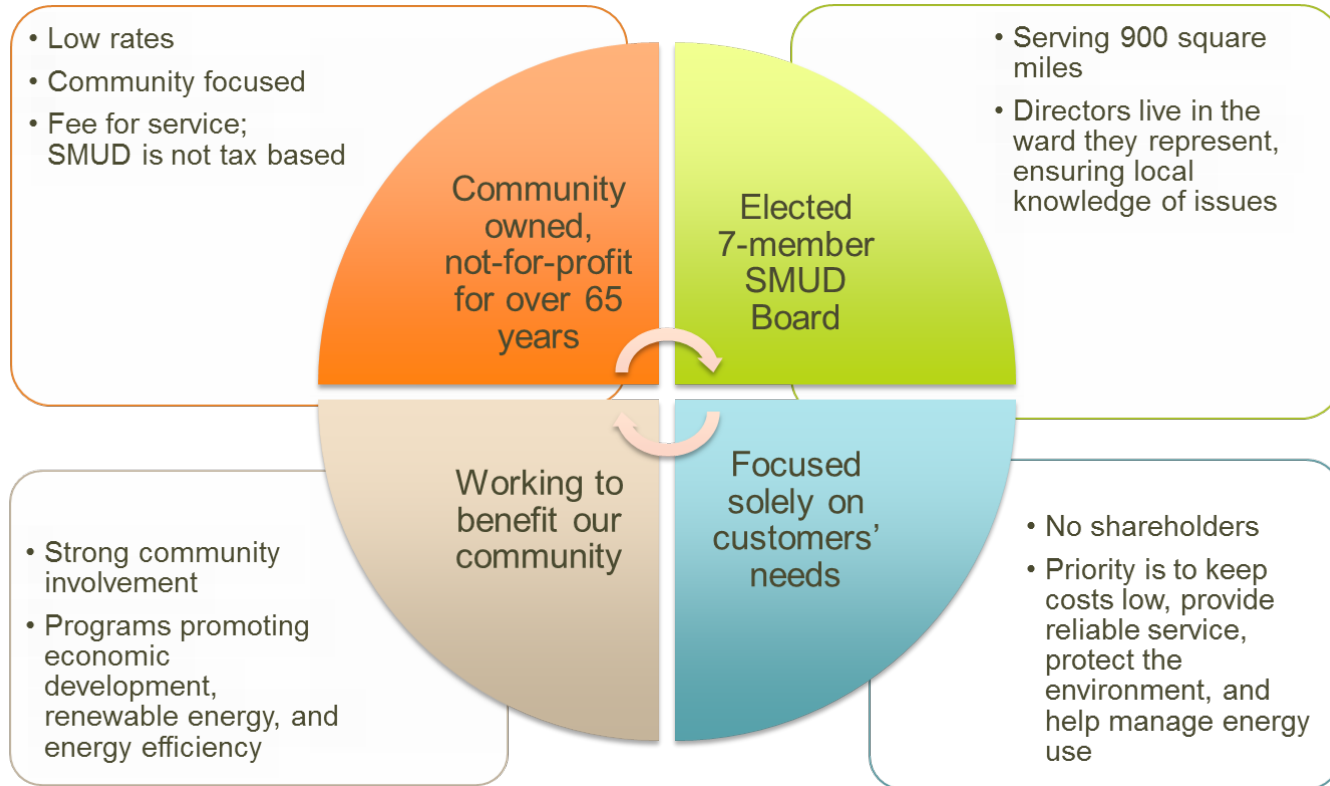
Evidence-Based Design for Healthcare Lighting: Where's the Evidence?

Oct 4, 2016 Robert Davis & Andrea Wilkerson, PNNL
Anjali Joseph, Clemson University

Tuning the Light in Senior Care

Oct 18, 2016 Robert Davis & Andrea Wilkerson, PNNL
Connie Samla, Sacramento Municipal Utility District

About SMUD



Why focus on senior care?

- Enhance the quality of a life
 - Circadian disruption often occurs when a person is placed in a nursing home
 - The average daylight exposure of a nursing home resident ranges from 1 to 10 minutes per day
 - ACC Care Center staff is dedicated to improving the lives of their residents
- We are all getting older...

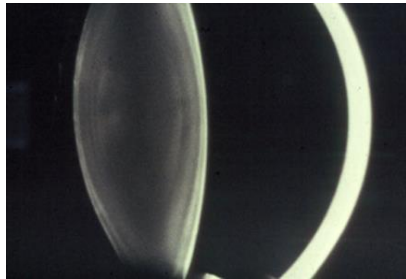
Why focus on senior care?

- Seniors have very specific lighting requirements:
 - Pupil is smaller and almost fixed in size
 - Less light enters the eye
 - Difficult to adjust to changes in brightness

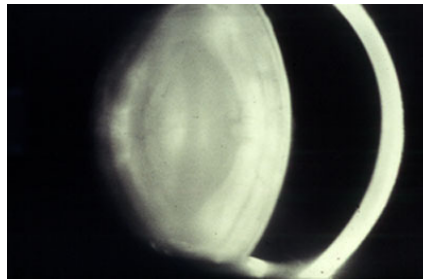


Why focus on senior care?

- Lens thickens and becomes slight amber color
 - Difficult to focus
 - Absorbs light and cancels the blue range
 - Causes light to scatter within the eye



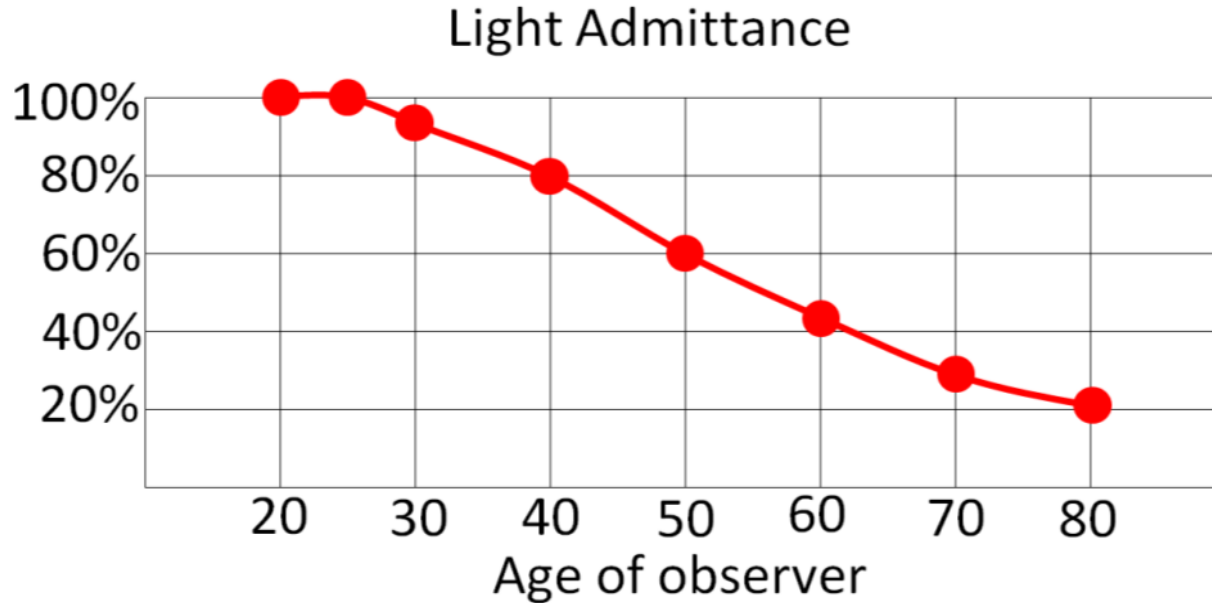
Lens of a 10 year old



Lens of a 65 year old

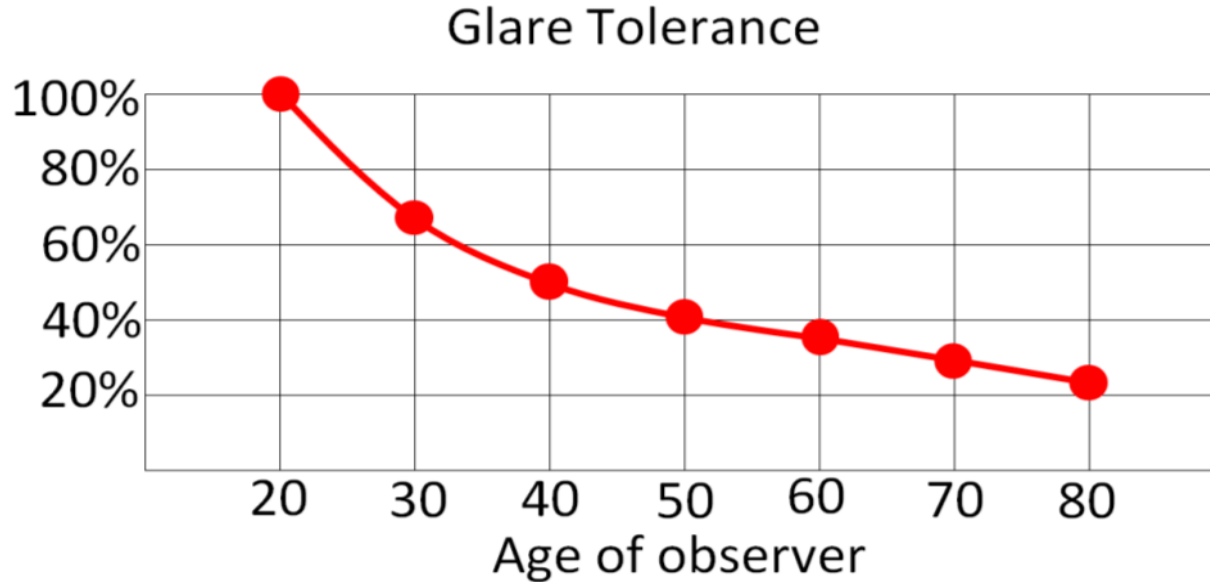
Why focus on senior care?

More light is needed as we age



Why focus on senior care?

but glare is less tolerated...



Why focus on senior care?

Eye diseases are also a factor



Images: National Eye Institute (NEI)



Why focus on senior care?

- Seniors have very specific lighting requirements and the existing lighting is often inadequate
- Lighting can have a big impact upon people...
- This sector is long overdue for a lighting makeover



Photo courtesy of Center of Design

Project description

Partner with the Department of Energy (DOE) Gateway Program, manufacturers and a local nursing facility ACC Care Center (nursing and rehabilitation center) to test:

- Tunable-white LED lighting systems (circadian)
- Indoor night lighting options (safety)

Project description

ACC Care Center

- Prominent nursing home in the Sacramento area
- 5-star rated facility
- Average age of resident is 87
- Wheelchair bound
- 2/3 of the current residents have been diagnosed with some form of dementia



Project description

Project Goals

- Investigate different lighting techniques and applications for upcoming remodel and addition
- Explore the potential benefits and challenges of circadian lighting:
 - Improve the lives of at least three residents
 - Enhance the nursing staff experience



Technologies used

Resident rooms: Fluorescent over-the-bed luminaire



Technologies used

Resident Rooms

- Tunable - white LED cove lighting above the beds and side walls
 - Cove lights hidden behind a plastic gutter
 - Commissioned controls per Lighting Research Center (LRC) protocol to change automatically (Light & Health Institute)
- LED over-the-bed light



Technologies used



Resident room schedules

7 am – 2 pm: 6000K

2 pm – 6 pm: 4100K

6 pm – 8 pm: 2700K

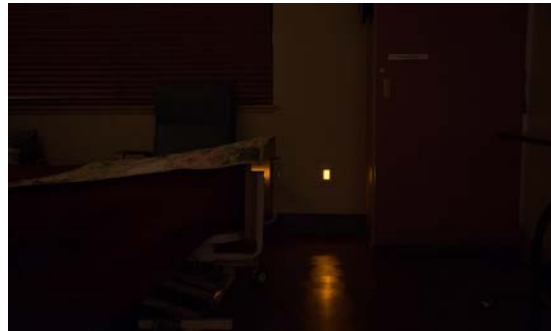
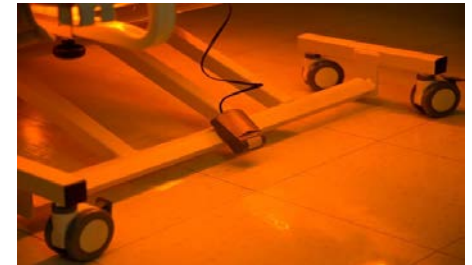
Nightlight option: 2400K

Technologies used

Resident Rooms

– Nightlights

- Amber LED rope lights on motion sensors under-the-bed
- Amber LED low-level lights on motion sensors in walls



Technologies used

Resident restrooms

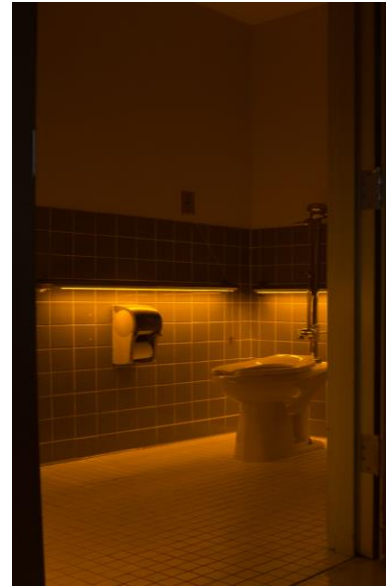
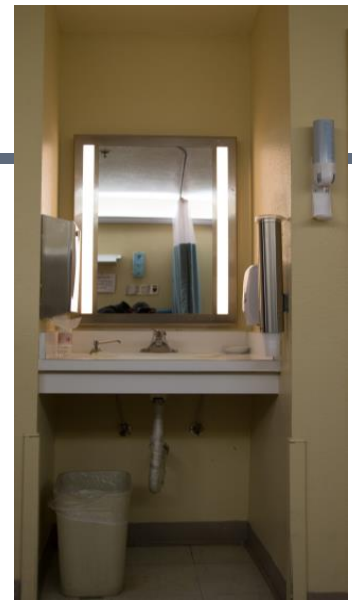
- Glary globe on ceiling
- Glary fluorescent luminaire over vanity



Technologies used

Resident restrooms

- Removed the vanity overhead luminaire
- Replaced the existing mirror with an illuminated LED mirror
- Replaced glary globe with surface mounted LED luminaire with nature scene (leaves)
- Replaced existing handrails with new handrails with integrated amber LEDs controlled by motion sensors



Technologies used

Hallway: 4100K two lamp fluorescent luminaires



Technologies used

Hallway

- Replaced the fluorescent luminaires with tunable - white surface mounted LED luminaires
- Added automatic controls for both dimming and tunable – white lighting



Technologies used

Hallway schedules

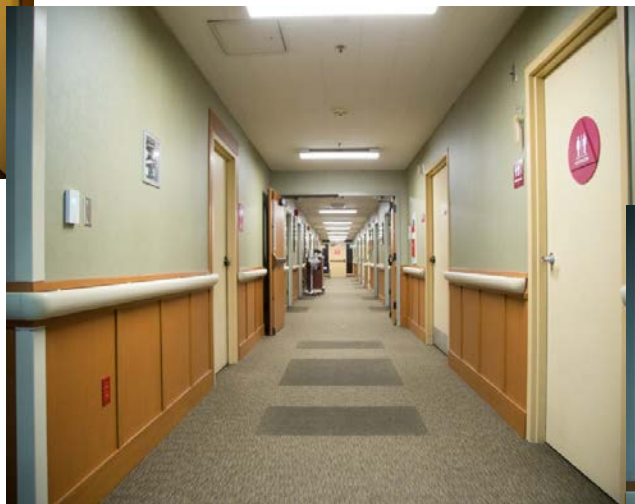
7 am – 2 pm: 6500K @ 66% output

2 pm – 6 pm: 4000K @ 66% output

6 pm – 7 am: 2700K @ 20% output

Over 65% energy savings





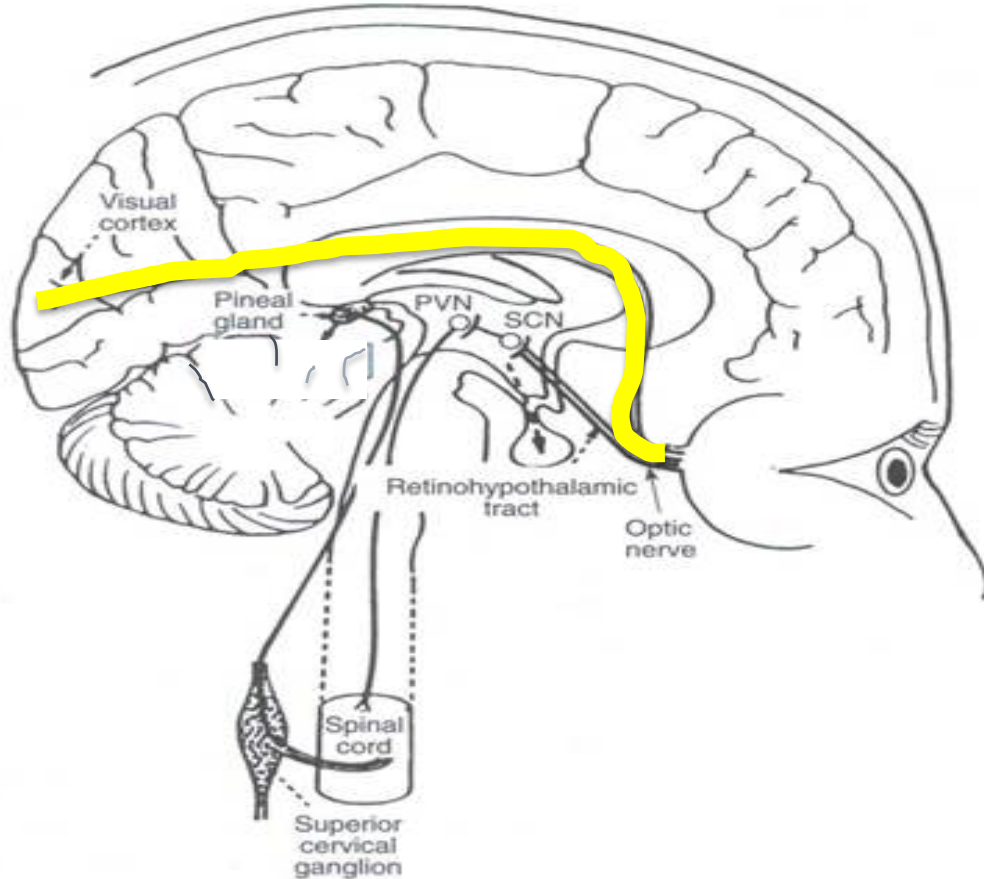
Results

Visual & Non-visual effects of light

Visual Pathway

Retinal Ganglion Cells (RGCs) carry signals from the rods and cones to the visual cortex, which controls vision

- *Writing*
- *Reading*
- *Watching*
- *Communicating*
- *Learning*
- *Focusing*
- *Appreciating*
- *Enjoying*





Resident room - Double

LED	WALL	COVE
Ambient	280 lx	70 lx
Bed center HOR	790 lx	110 lx
Bed reading VERT	1340 lx	55 lx

FLUORESCENT	
Ambient	95 lx
Bed center HOR	190 lx
Bed reading VERT	390 lx





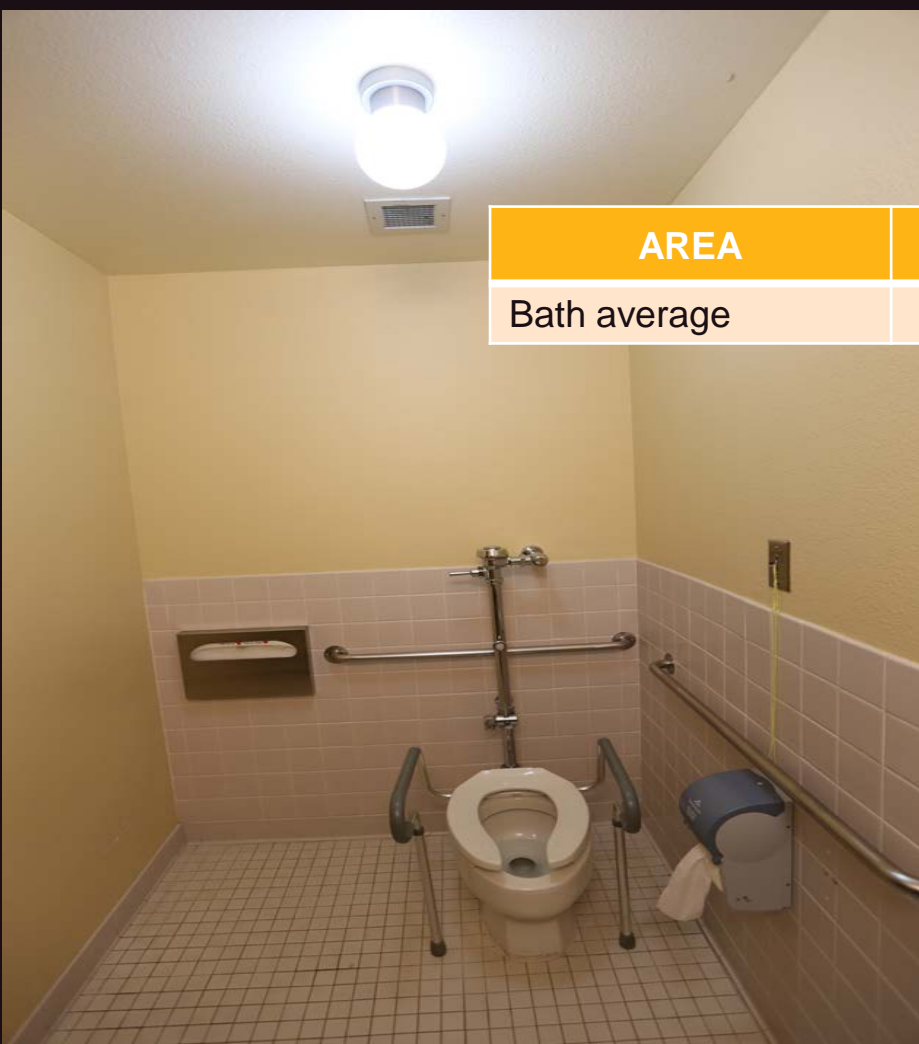
Resident room - Single

LED	WALL	COVE
Ambient 1	130 lx	25 lx
Ambient 2	320 lx	70 lx
Bed center HOR	560 lx	80 lx
Bed reading VERT	1400 lx	60 lx

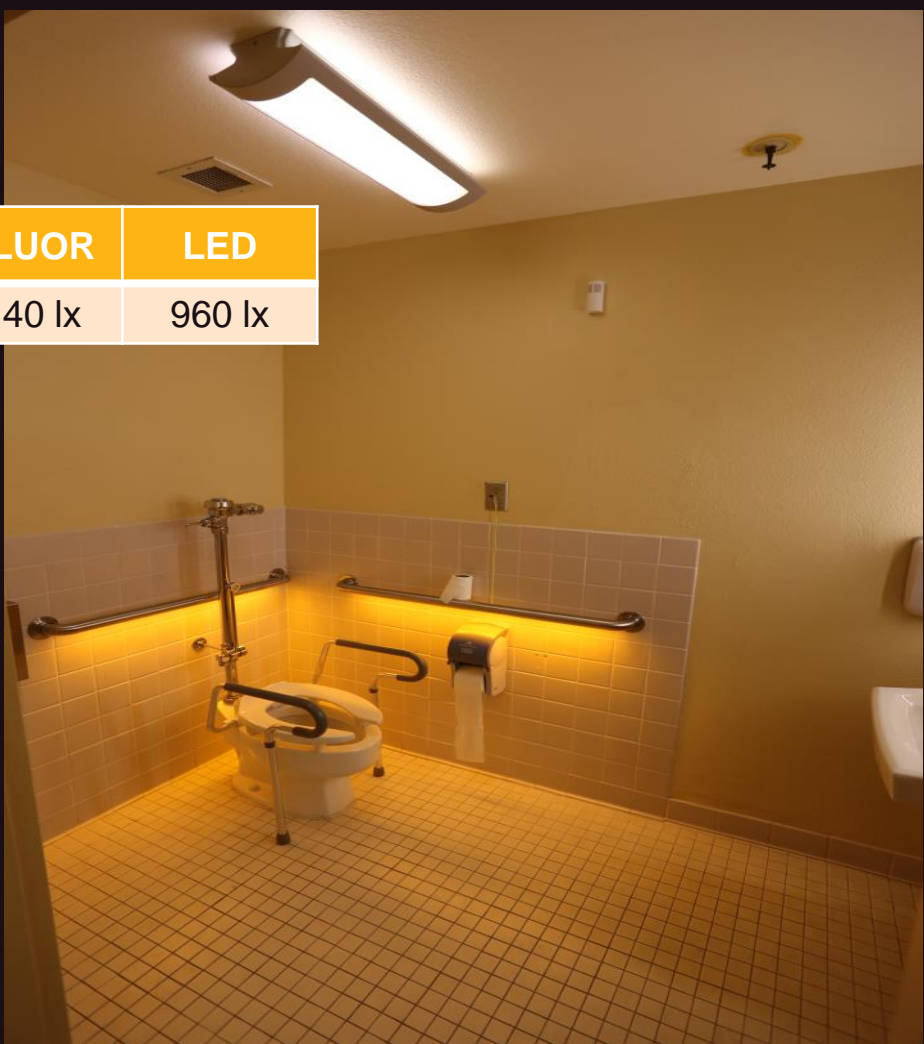
FLUORESCENT

Ambient 1	35 lx
Ambient 2	90 lx
Bed center HOR	190 lx
Bed reading VERT	400 lx





AREA	FLUOR	LED
Bath average	140 lx	960 lx

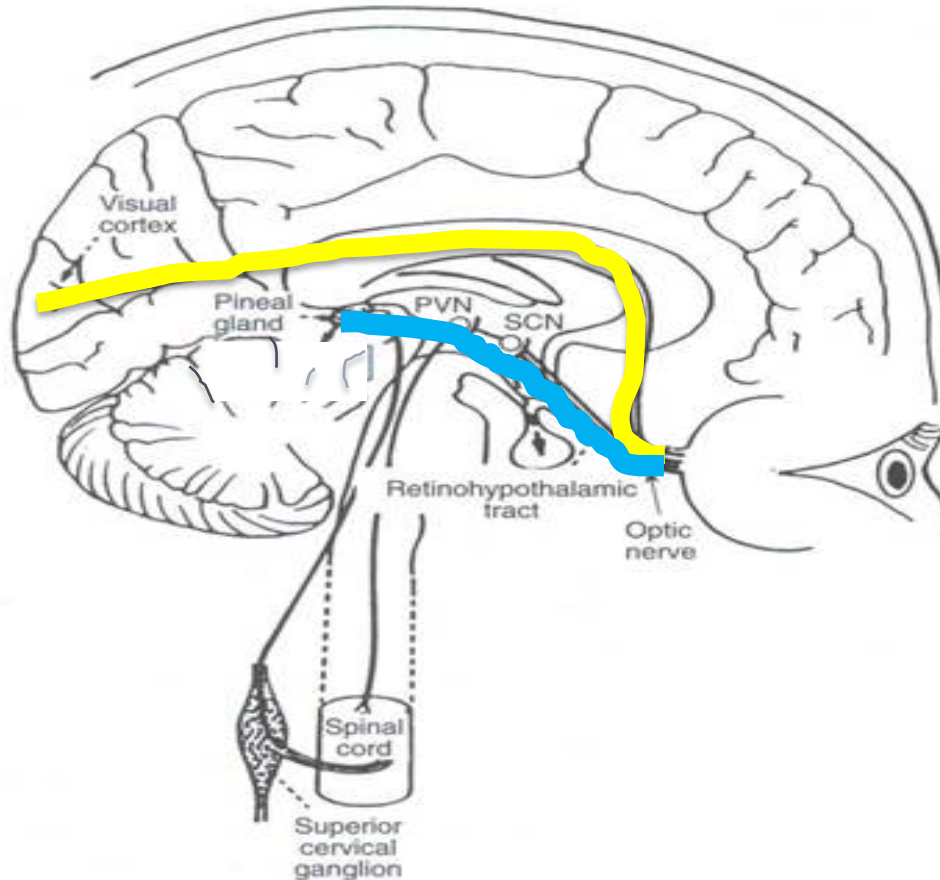


Visual & Non-visual effects of light

Visual Pathway

Retinal Ganglion Cells (RGCs) carry signals from the rods and cones to the visual cortex, which controls vision

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- *Learning*
- *Focusing*
- *Appreciating*
- *Enjoying*



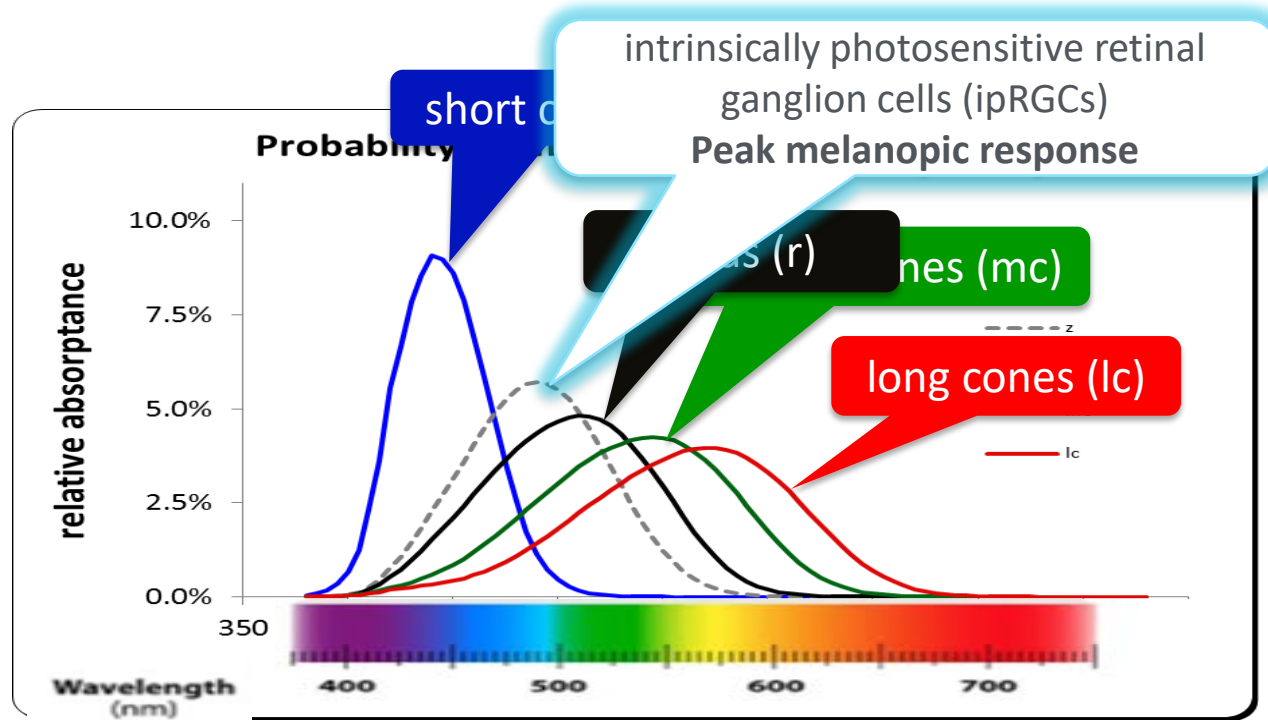
Non-Visual Pathway

ipRGCs are photoreceptors connected to the hypothalamus, which controls many biological effects

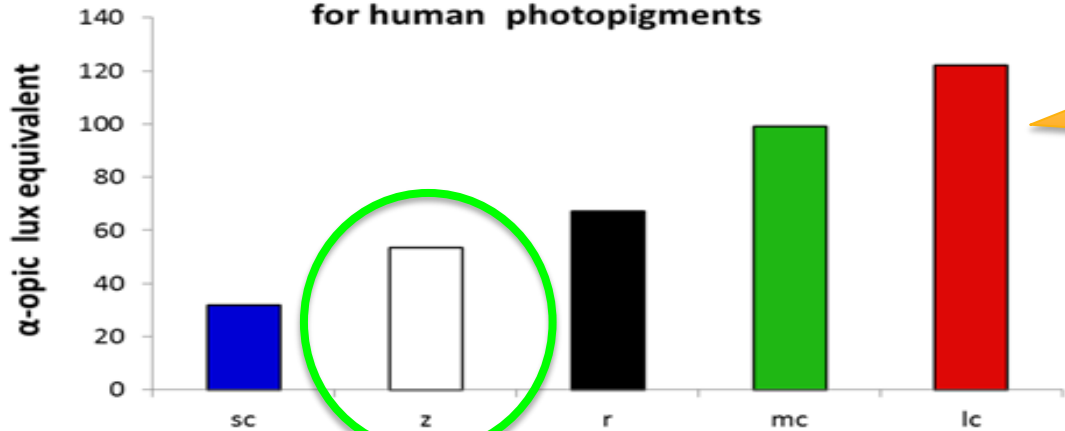
- *Suppressing melatonin (sleep hormone)*
- *Enhancing alertness*
- *Affecting cognition*

- *Photic*
- *Non-photic*

Photoreceptor responses



Effective illuminance for human photopigments



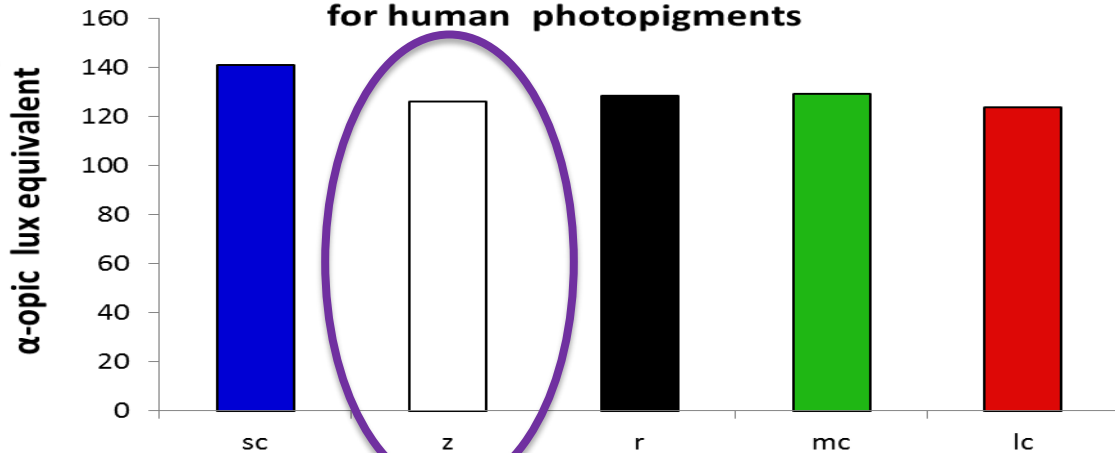
**2700K LED,
100% output**



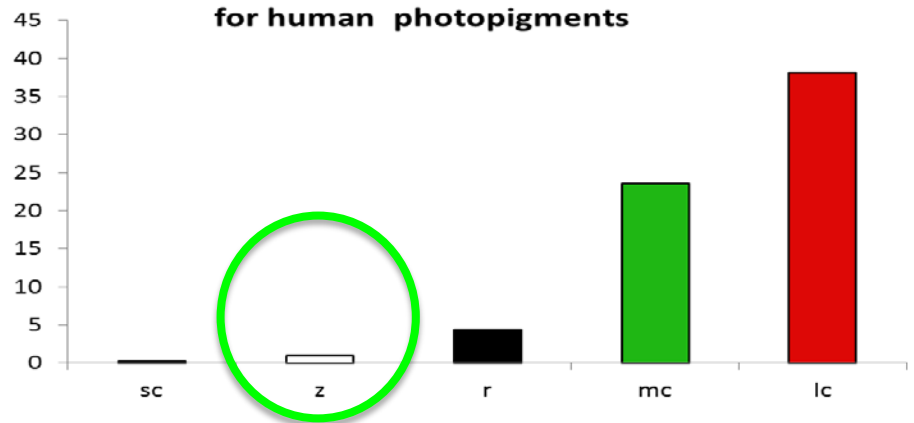
Lucas et al, Trends in Neuroscience, 2014

**6500K LED,
100% output**

Effective illuminance for human photopigments



**Effective illuminance
for human photopigments**



Equivalent Melanopic Illuminance (at 100 lx)

Light Source	Melanopic Illuminance (m-lx)
Fluorescent 4100K	61
LED 4500K	79
LED 6500K	98
LED 2700K	43
LED Amber	11



FLUORESCENT	
Ave. HOR	330 lx
Ave. VERT Eye	120 lx
Ave. VERT Eye Melanopic	73 m-lx

Corridors



LED	
Ave. HOR (6500K, 66%)	280 lx
Ave. VERT Eye	100 lx
Ave. VERT Melanopic	98 m-lx
Ave. HOR (2700K, 20%)	100 lx
Ave. VERT Eye	35 lx
Ave. VERT Melanopic	15 m-lx

What do the numbers mean? (EML, CS, . . .)

At least five important factors affect our response:

1. Spectral content of the light source
2. Intensity level of the light source
3. Duration of exposure
4. Timing of the exposure
5. Age / health of individuals

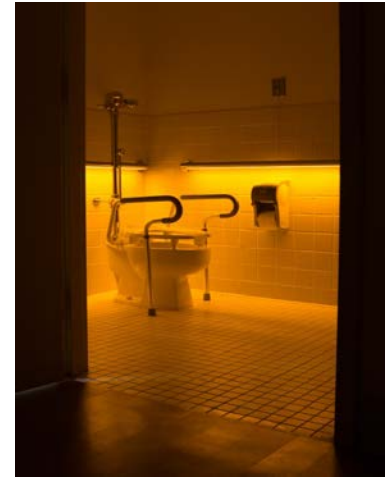
Awesome outcomes!

Awesome outcomes!

Reduction in Falls

“The quarter before the lights were installed we had 5 falls on Cherry Lane. The quarter after installation the number reduced to 3 but, more importantly, *there were no falls on Cherry Lane in the last three months.*”

- ACC Administrator



Awesome outcomes!

- Residents are sleeping through the night
 - Sleeping in their beds
 - They LOVE the night lights
 - Reduction in psychotropic and sleep medications
- 41% reduction in behaviors
 - Yelling
 - Agitation
 - Crying
- 71% reduction in behaviors in one particular dementia resident

Awesome outcomes!

- Other residents hanging out in “Cherry Lane”
- Nurses embracing the new lighting for both the residents and the late night shift
- Attending Physician is highly involved
 - Currently prescribes daylighting
 - Taking this information to the medical community
- Family members and staff are being educated on circadian lighting
 - Many have asked when their loved one will receive the new lighting

Awesome outcomes!

“ACC will be incorporating many of the lighting solutions piloted in this project as best practices in terms of fall risk, sleep enhancement and non-pharmacological approaches for behaviors related to dementia.”

ACC Administrator

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