Measuring and prescribing preferred light intensity and color

Peter Borden, Ph.D. and Michele Klein
Jasper Ridge Inc.

Envision Conference, September 19, 2014

Outline

Motivation

System design

Protocol for use

Converting measurement to recommendation

Clinical studies

Conclusions

Motivation

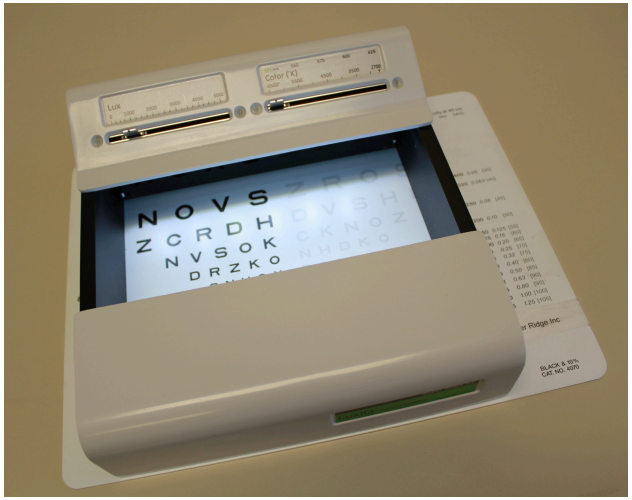
- Determine lighting needs in offices or homes without trial and error
- Prescribe optimum lamps and/or light bulbs
- Determine lighting color effects
- Conduct a wide variety of clinical and research studies
- Chart patient lighting changes over time to observe disease progression

…without a bag of bulbs

…or a lamp station

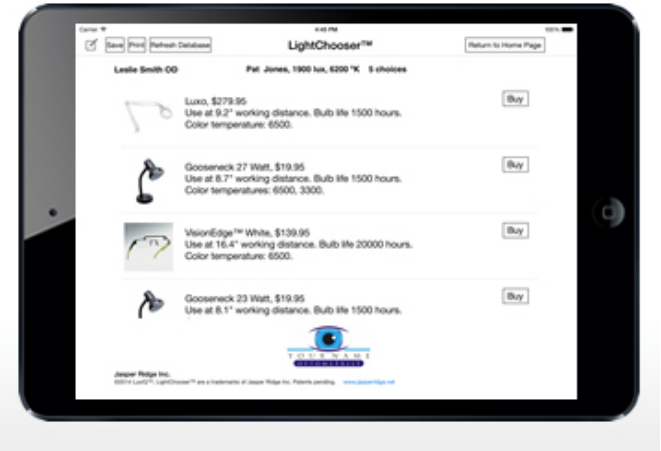
(Dr. K. Schoessow's idea)

Concept



Measure

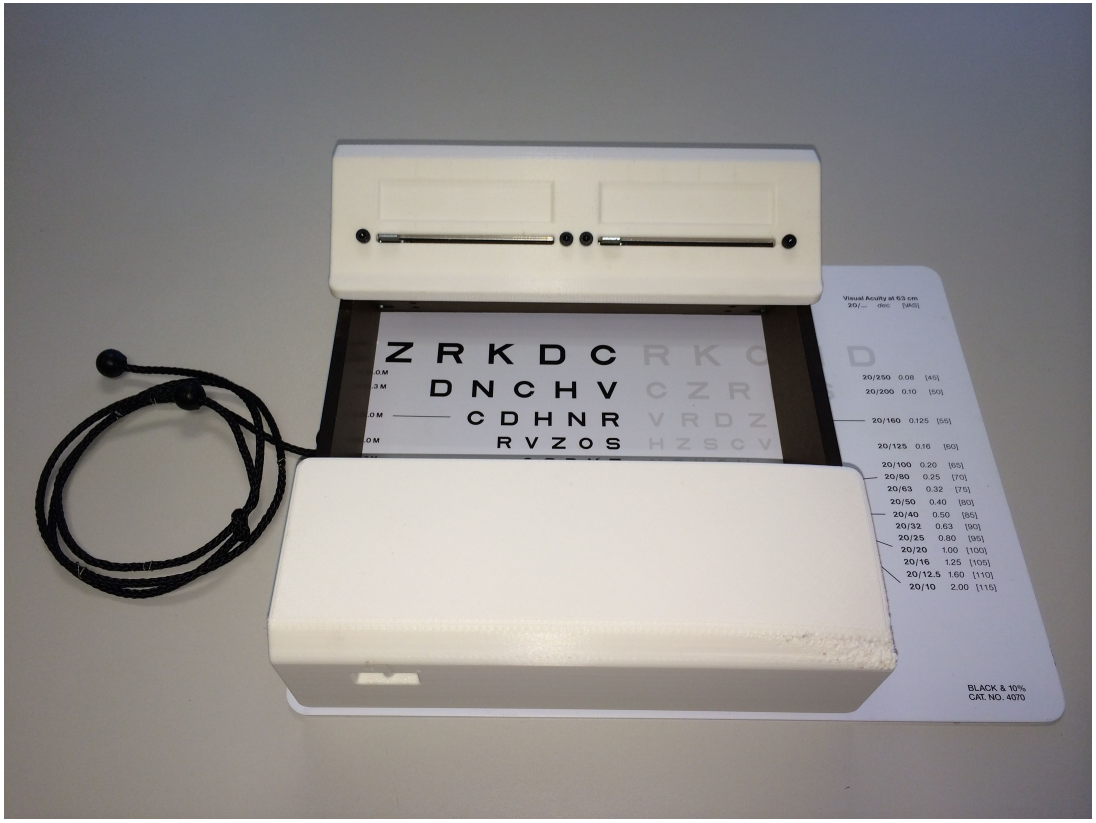
- Find preferred illuminance and color temperature or color



Recommend

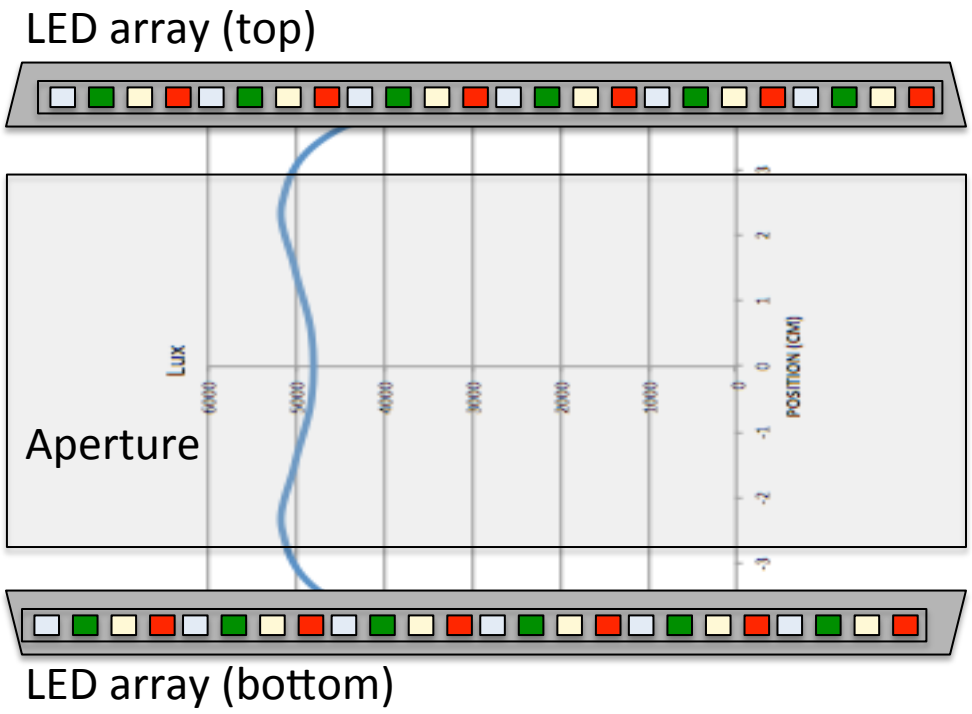
- Translate measurement to a recommendation for common lamps or bulbs using table or app

Place LuxIQ™ over reading material



Standard eye chart, newspaper or book…

LuxIQ™ configuration



Processor

LED drivers

Rechargeable Li batteries

Shallow lighting angle

- minimizes glare,
- increases uniformity

Aperture

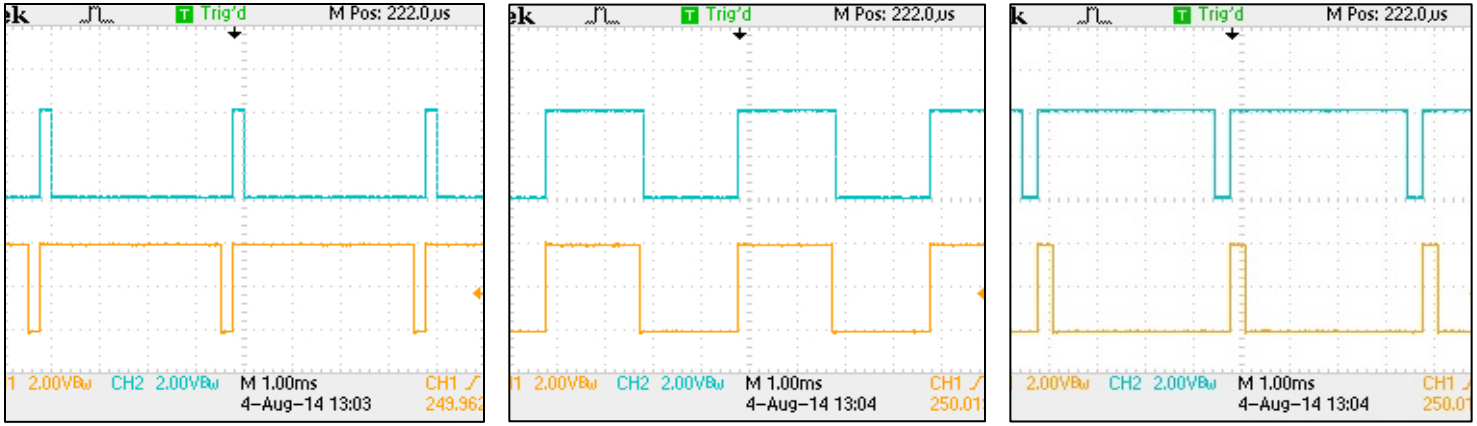
- 7 x 18 cm
- Acuity charts, books, newspaper

Integrated processor

Brightness independent of color

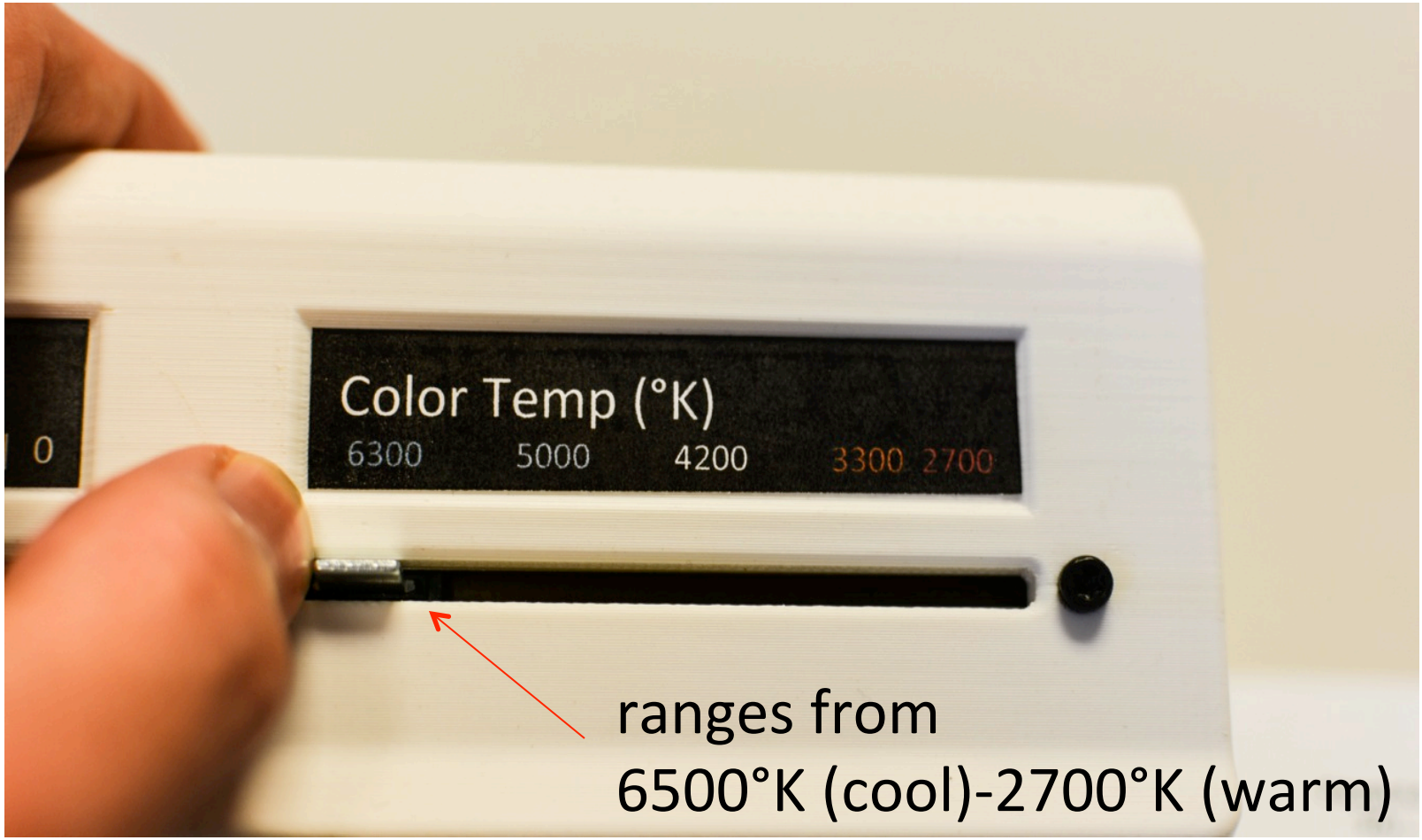
LuxIQ brightness is independent of color (0 – 5000 lux)

- Ratio of warm/cold intensity sets white color temperature 2700 (warm white) - 6500°K (cool or natural white)
- Ratio of red/green intensity sets color 525 nm (green) - 625 nm (red)



2700°K 4700°K 6500°K

Select color temperature with slider



Cool and warm white

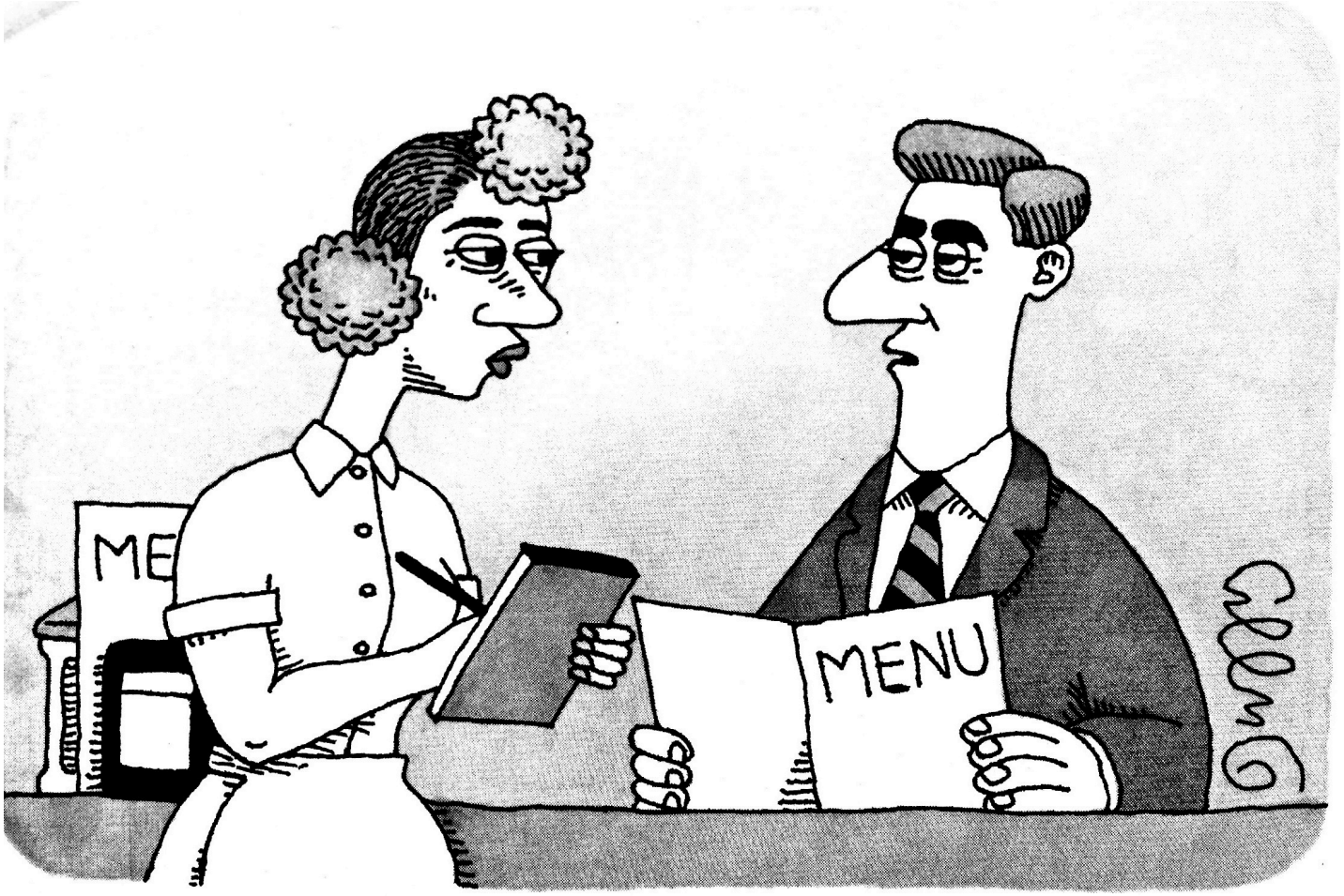
Assessment protocol

- Measure near acuity using ambient light
- Place LuxIQ over reading chart
- Determine preferred lux (illuminance)
- Determine preferred color temperature (°K)
- Re-check preferred lux with preferred color
- Record near acuity w/preferred lighting
- Convert assessment to recommendation

Lux quantifies brightness; color may improve comfort

Credit to Dr. G. Goodrich, Dr. M. Perlmutter (home use protocol available)

Choices



"Two eggs, any style? My mind is reeling."

Endless choices … the light bulb aisle

Convert assessment to recommendation

Light bulb calculator

LUMENS TO REACH A LUX LEVEL

6 to 32 inches from desk

Lux	6	8	10	12	14	16	18	20	22	24	26	28	30	32
250	46	83	129	186	253	330	418	516	625	743	872	1012	1161	1321
500	93	165	258	372	506	661	836	1032	1249	1486	1745	2023	2323	2643
750	139	248	387	557	759	991	1254	1548	1874	2230	2617	3035	3484	3964
1000	186	330	516	743	1012	1321	1672	2065	2498	2973	3489	4046	4645	5285
1250	232	413	645	929	1265	1652	2090	2581	3123	3716	4361	5058	5806	6606
1500	279	495	774	1115	1517	1982	2508	3097	3747	4459	5234	6070	6968	7928
1750	325	578	903	1301	1770	2312	2926	3613	4372	5203	6106	7081	8129	9249
2000	372	661	1032	1486	2023	2643	3345	4129	4996	5946	6978	8093	9290	10570
2250	418	743	1161	1672	2276	2973	3763	4645	5621	6689	7850	9104	10452	11892
2500	465	826	1290	1858	2529	3303	4181	5161	6245	7432	8723	10116	11613	13213
2750	511	908	1419	2044	2782	3634	4599	5677	6870	8175	9595	11128	12774	14534
3000	557	991	1548	2230	3035	3964	5017	6194	7494	8919	10467	12139	13935	15855
3250	604	1074	1677	2415	3288	4294	5435	6710	8119	9662	11339	13151	15097	17177
3500	650	1156	1806	2601	3541	4625	5853	7226	8743	10405	12212	14163	16258	18498
3750	697	1239	1935	2787	3794	4955	6271	7742	9368	11148	13084	15174	17419	19819
4000	743	1321	2065	2973	4046	5285	6689	8258	9992	11892	13956	16186	18581	21141
4250	790	1404	2194	3159	4299	5615	7107	8774	10617	12635	14828	17197	19742	22462
4500	836	1486	2323	3345	4552	5946	7525	9290	11241	13378	15701	18209	20903	23783
4750	883	1569	2452	3530	4805	6276	7943	9806	11866	14121	16573	19221	22064	25104
5000	929	1652	2581	3716	5058	6606	8361	10323	12490	14864	17445	20232	23226	26426

Red indicates more than one bulb may be required

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Patents Pending

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Light Bulb Calculator: 2000 lux

LUMENS TO REACH A LUX LEVEL

6 to 32 inches from desk

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1250	232	413	645	929	1265	1652	2090	2581	3123	3716	4361	5058	5806	6606
1500	279	495	774	1115	1517	1982	2508	3097	3747	4459	5234	6070	6968	7928
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Light Bulb Calculator: 10” from desk

LUMENS TO REACH A LUX LEVEL

6 to 32 inches from desk

Lux	6	8	10	12	14	16	18	20	22	24	26	28	30	32
250	46	83	[illegible]	186	253	330	418	516	625	743	872	1012	1161	1321
500	93	165	[illegible]	372	506	661	836	1032	1249	1486	1745	2023	2323	2643
750	139	248	[illegible]	557	759	991	1254	1548	1874	2230	2617	3035	3484	3964
1000	186	330	[illegible]	743	1012	1321	1672	2065	2498	2973	3489	4046	4645	5285
1250	232	413	[illegible]	929	1265	1652	2090	2581	3123	3716	4361	5058	5806	6606
1500	279	495	[illegible]	1115	1517	1982	2508	3097	3747	4459	5234	6070	6968	7928
1750	325	578	[illegible]	1301	1770	2312	2926	3613	4372	5203	6106	7081	8129	9249
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Light Bulb Calculator: get ~1000 lumen bulb!

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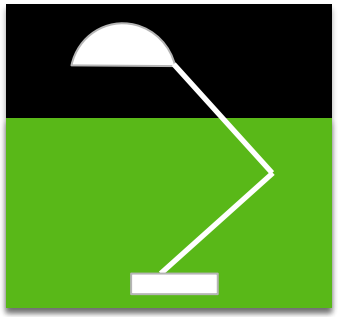
Red indicates more than one bulb may be required

LightChooser™ App

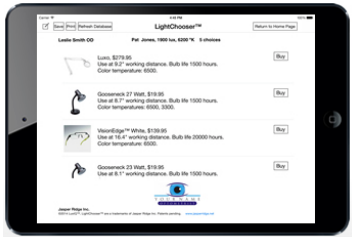
Light bulbs

- Calculates bulb lumens and watts given distance from desk
- Uses same model as the light bulb calculator (cone angle, reflectance)



Lamps

- Recommends lamps from database
- Lamps calibrated using standard procedure



LightChooser™: home screen

Print | Refresh Database | **LightChooser™** | Logout

Practitioner

Doctor | Name | OD

Patient

Patient | MI | Name

Prescription/Recommendation

Lux 2100

Color Temp 5000 °K

Intended use of light

☑ Fixed (Desk,Easy chair) ☐ Portable (Travel, Restaurant) ☐ Personal (Bed, Plane)

YOUR NAME OPTOMETRIST

Dispense Lamps

Select Light Bulbs

LightChooser™: bulb screen

Print | Refresh Database | **LightChooser™** | Return to Home Page

Doctor Name OD **Patient Name, 2100 lux, 5000 °K**

Distance from lamp to work surface (inches)

0" 18" 36" 9

For 2100 Lux at 9", use 1118 Lumen Bulb (may require more than one bulb)

Electricity cost per year

Mins/day	40		Incandescent	$2.14	75	Watts	CFL	$0.60	19	Watts
Elect rate	11	¢/hr	Halogen	$1.76	47	Watts	LED	$0.30	11	Watts

YOUR NAME OPTOMETRIST

LightChooser™: lamp screen

Print | Refresh Database | **LightChooser™** | Return to Home Page

Clinician Name **Patient Name, 2000 lux, 5000 ºK 11 choices**

Ott 13 Watt task, $59.95
Use at 11.4" working distance. Bulb life 1500 hours.
Color temperature (ºK): 6500.

Gooseneck 23 Watt CFL, $19.95
Use at 11.5" working distance. Bulb life 1500 hours.
Color temperatures (ºK): 6500, 3300.

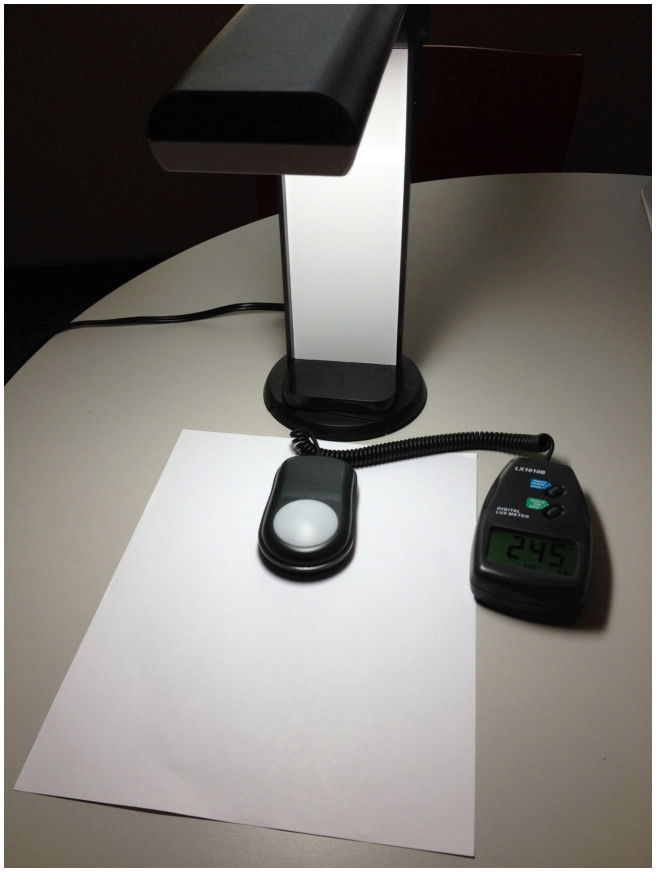
Luxo stand, $165.00
Use at 11.3" working distance. Bulb life 1500 hours.
Color temperature (ºK): 6500.

Luxo, $279.95
Use at 8.7" working distance. Bulb life 1500 hours.
Color temperature (ºK): 6500.

How lamps are added to the database

Standard procedure:

- Darken room
- Determine usable range of desk-lamp distance
- Measure illuminance vs. desk-lamp distance
- Fit to equation
- Add to lamp database

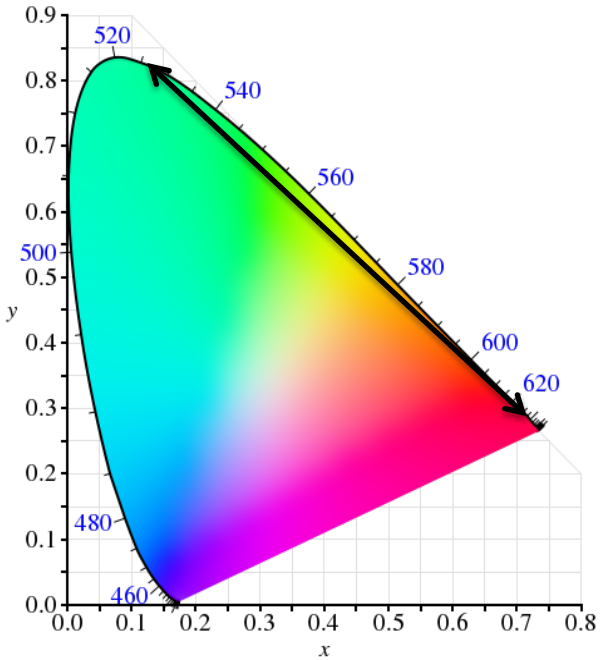


Adding lamps to the database is a free service for LuxIQ owners.

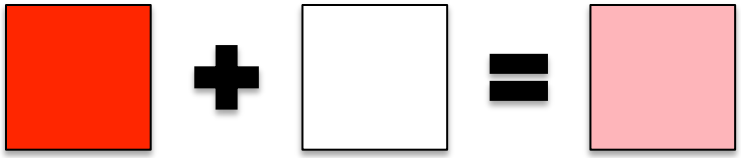
Now switch to colored light

Colors and tints

- Red + green for color



- Color + white for tints

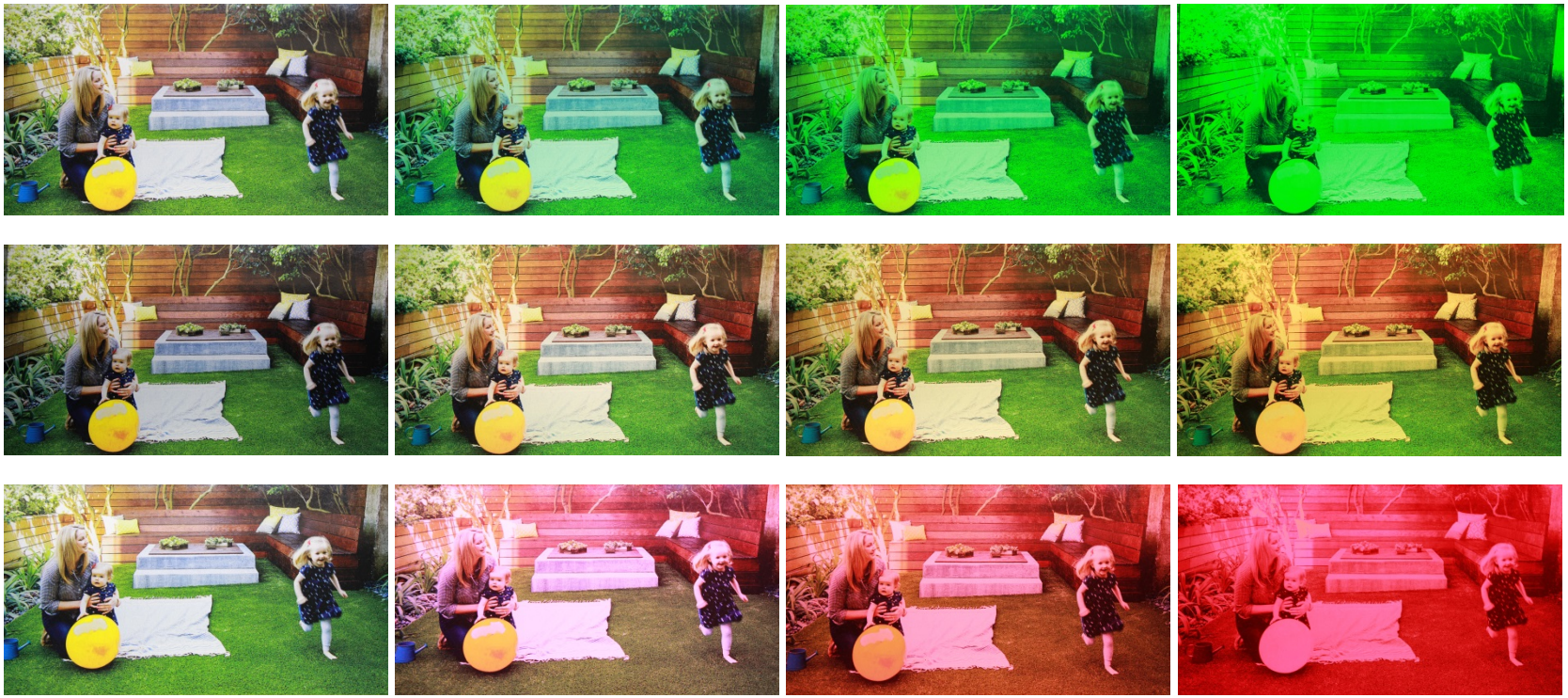


Color and Tint

green

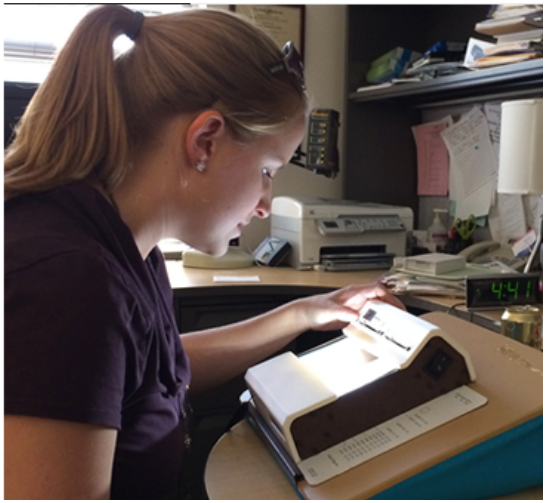
yellow

red



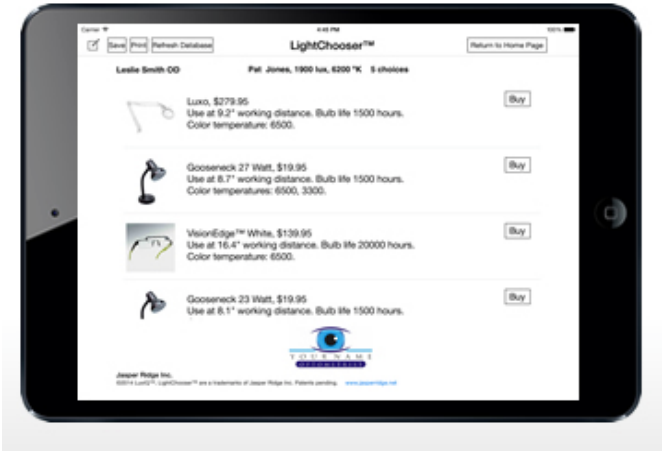
100% white 70% 30% 0%

Measure and prescribe preferred light intensity and color



Assess lighting

- Find preferred illuminance and color temperature or tint



Convert to recommendation

- Light Bulb calculator - bulbs
- LightChooser app – lamps, bulbs

Related presentations and sessions

VA TBI Research Forum 2014

"*Characterizing and Prescribing Preferred Light Intensity and Color*", P. Borden, M. Klein, G. Goodrich, D. Patten, 4th Annual VA TBI Research Forum, Palo Alto, CA, March 2014.

Envision Conference 2014

"Pre-Conference Research Panel: Translating Research into Clinical Practice". Moderator: Donald Fletcher, MD., 4:00 pm Wed, Sept 17, Nicollet D

"Is Low Vision Lighting Coming of Age," Talk C22, Moderators: Gregory Goodrich, PhD; Donald Fletcher, MD; and Karen Kendrick, OTR/L, CLVT, 9:15 am Fri, Sept 19, Lakeshore B

"The Science Behind Assessing and Recommending Task Lighting," Talk C30, Moderators: Peter Borden, PhD; Michele Klein. 1:15 pm Fri, Sept 19, Lakeshore B

AAO 2014

"*Quantifying Patient Lighting Needs to Improve Low Vision Clinical Practice and Patient Performance*" G. Goodrich, S. Ingalla, M. Dolkas, 2014 AAO Conference, Denver

AOTA 2015

"Home Environment Evaluation for Individuals with Vision Loss: Evidence Guiding Best Practice," B. Barstow, PhD, OTR/L, SCLV, Monica S. Perlmutter, OTD, OTR/L, SCLV, conference workshop.

Thank you!

pborden@jasperridge.net
www.jasperridge.net
(650) 520.6600

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