How IoT Improves Well-being: Home Lighting Beyond Illumination

Kars-Michiel H. Lenssen
Signify Research, The Netherlands
Kars-Michiel.Lenssen@Signify.com

Internet of Things Applications USA, 20th November 2019

Connected Lighting & the Internet of Things

Lighting is everywhere – enabled by connectivity, it will deliver ever greater value beyond illumination, including IoT backbone

Signify

Outline

1. Intro to Connected Lighting & The Internet of Things
2. Smart Home
   - Four segments → Health & Well-being
   - Philips Hue
3. Human Centric Lighting
   - Effects of light
   - Scientific evidence
4. Recent data-based field studies
   - with connected lighting & motion sensors
   - with connected lighting & wearables

Smart Home

Smart Home: four segments

- Safety & security
- Energy management
- Entertainment & content
- Health & Well-being

Signify

Smart Home: four areas

Health & Well-being is forecasted to be the fastest growing segment

Safety & security

Energy management

Entertainment & content

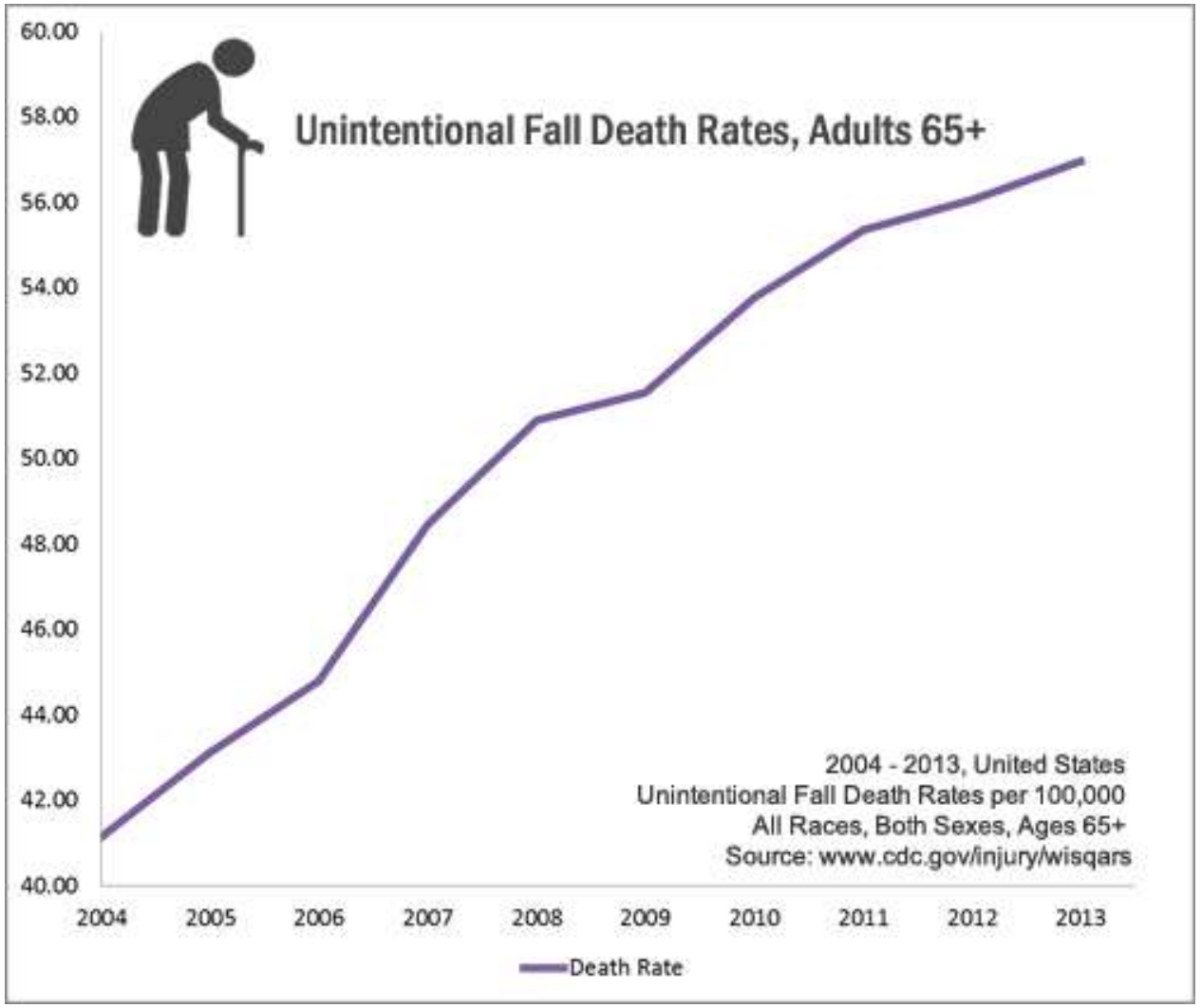
Health & Well-being

signify

Health & Well-being use case example

Independent living for Elderly; home monitoring

Fall death rates in the United States



Philips Hue

#1 smart home lighting system to light your home and garden smarter, used in over 150 countries and five continents

Open API

>750 3rd-party apps

Hue motion sensor

https://youtu.be/1SmRYug10y4

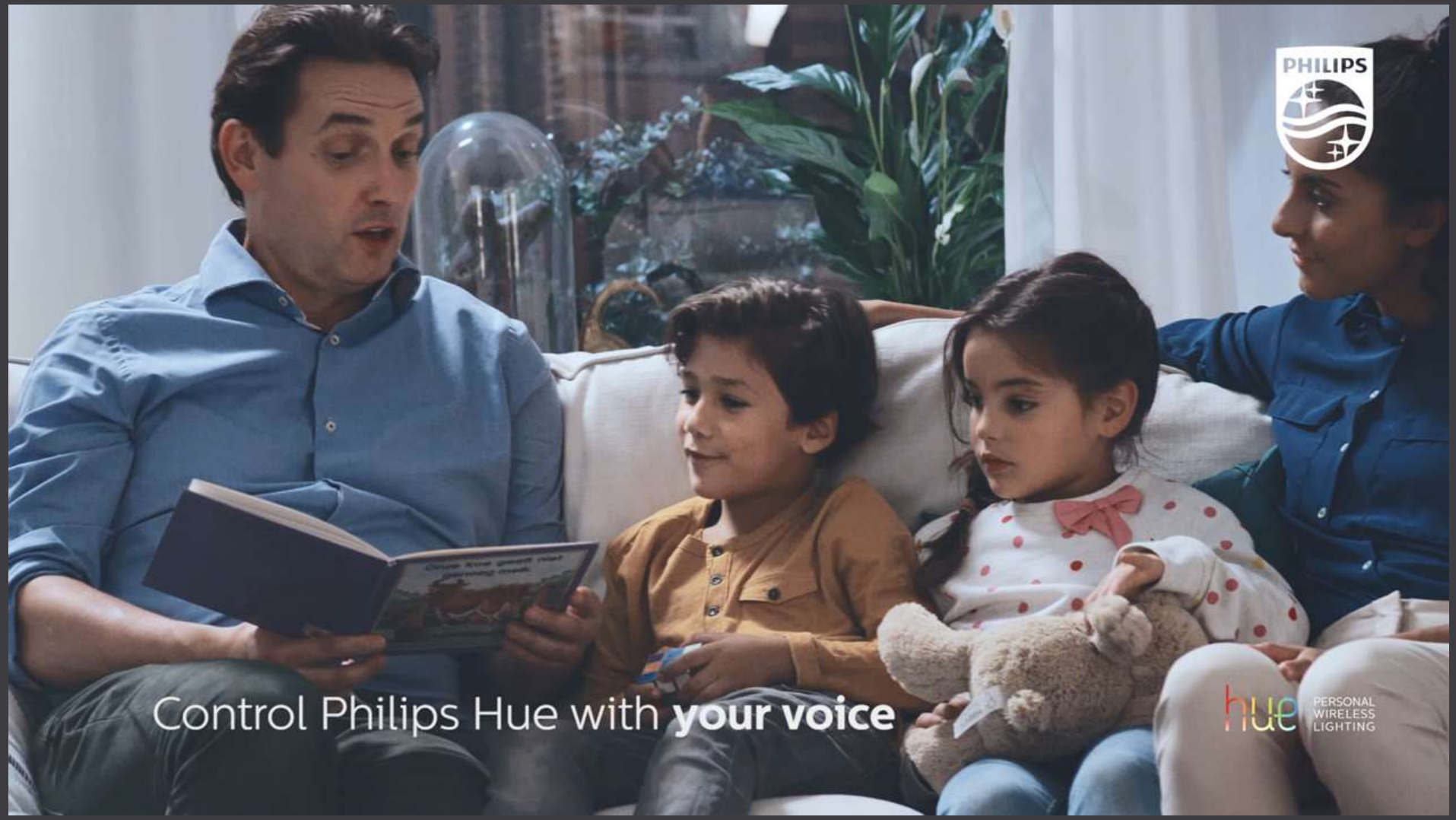
Signify

Friends of Hue: Apple Homekit

Friends of Hue: Nest

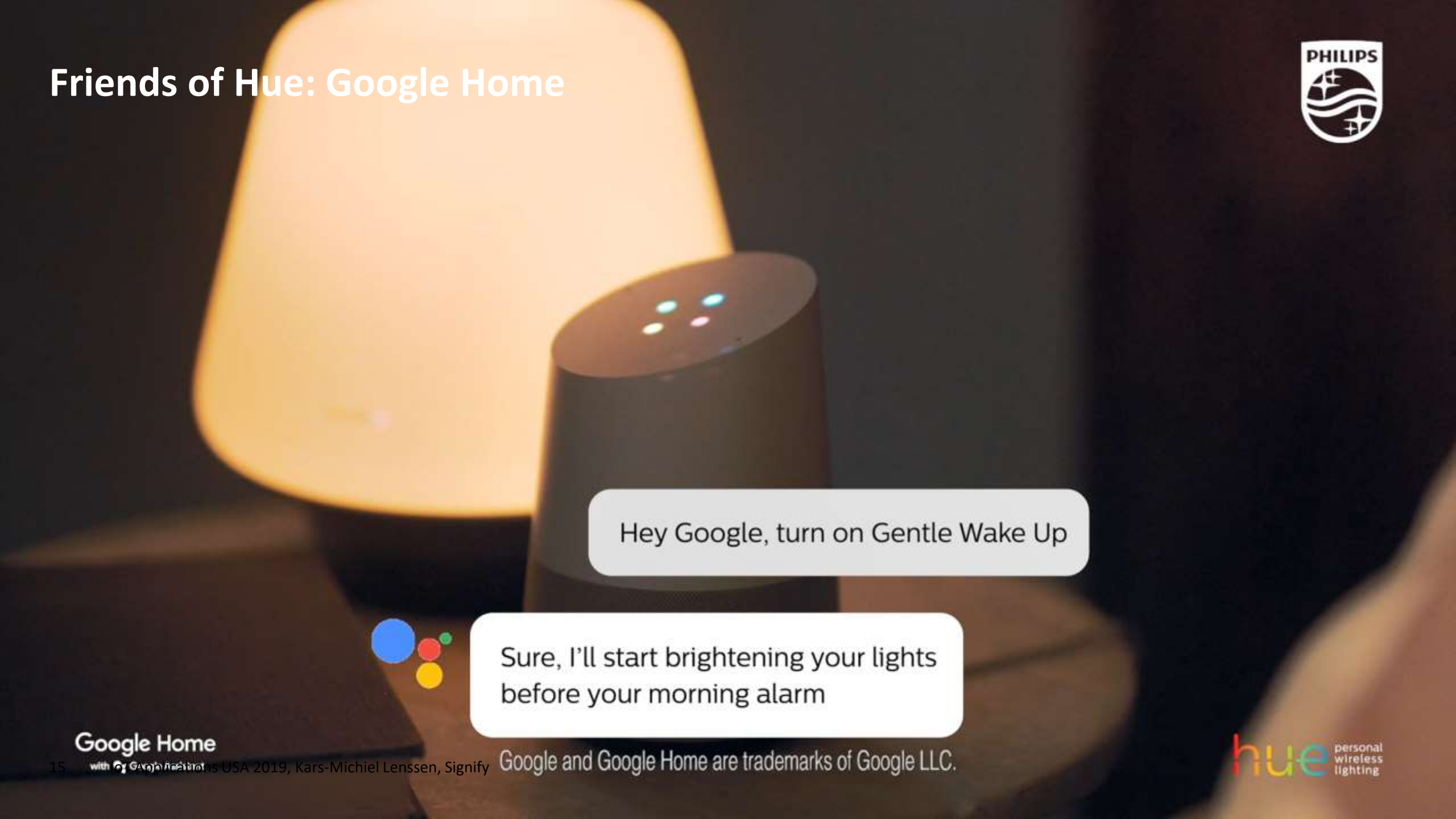
Signify

Friends of Hue: Amazon Alexa



signify

Friends of Hue: Google Home

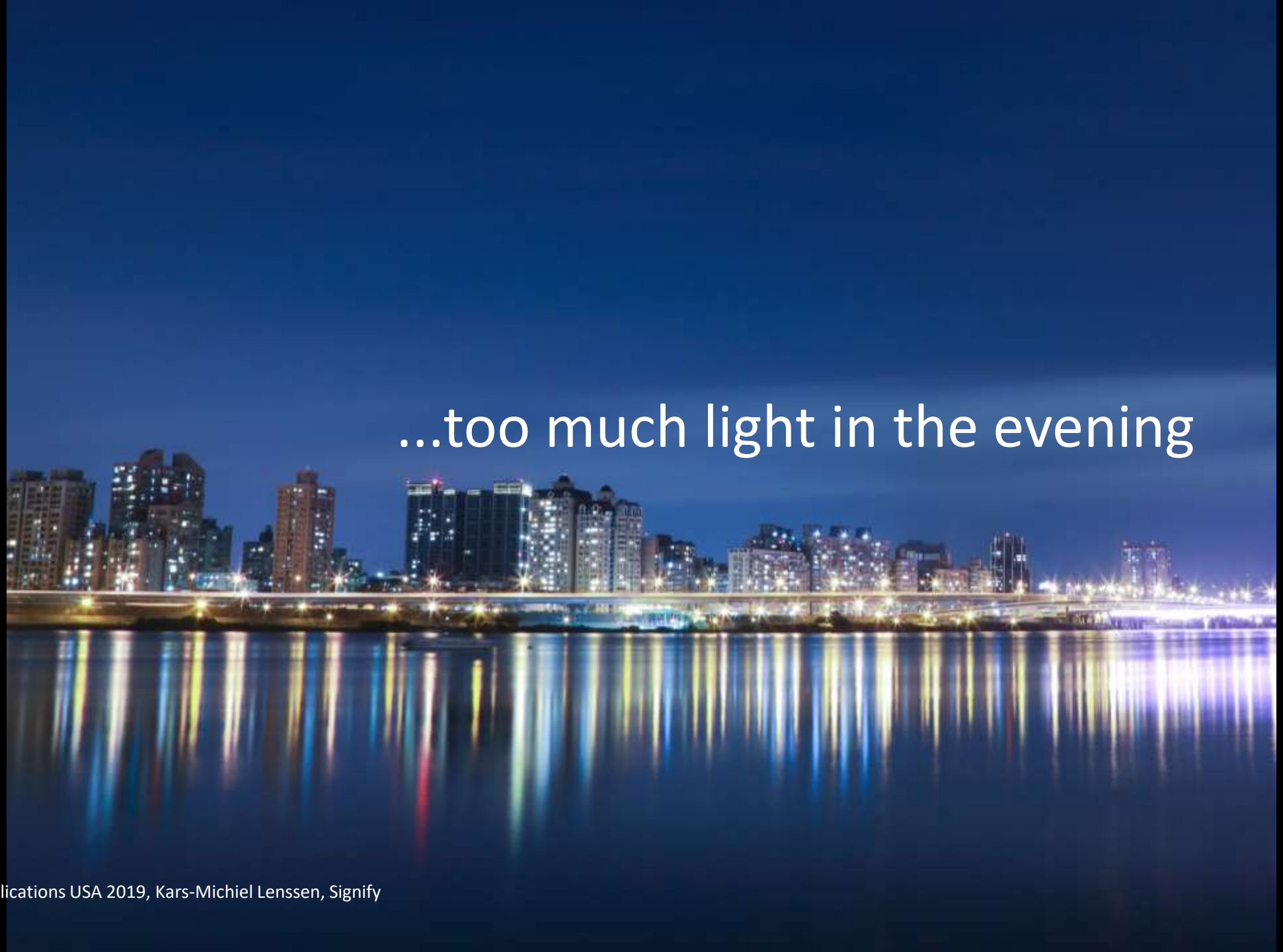


Smart Home:
Human Centric Lighting


Light is the most powerful regulator
of the human day-night-rhythm

Signify

Signify



Signify

Some consequences

Circadian misentrainment…

Sleep problems…

Compromised vision,
well-being and functioning…

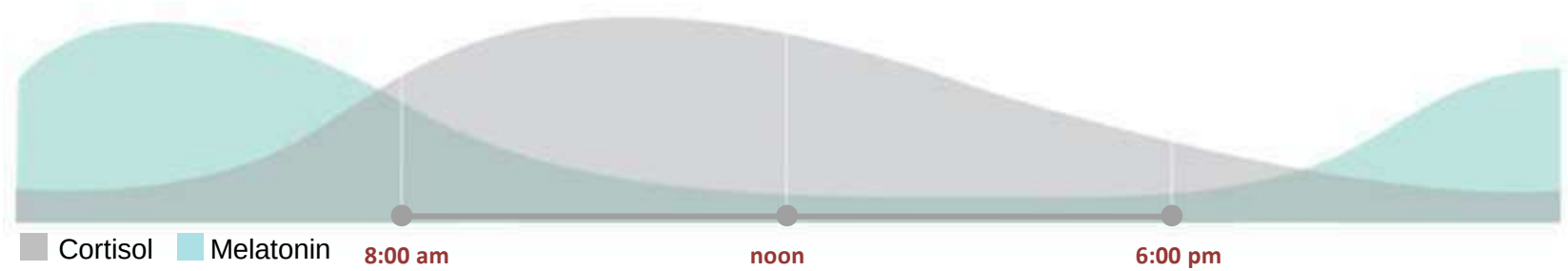
Signify

Studies towards effects of sleep deprivation

Emotional responses	Cognitive responses	Somatic responses
Fluctuations in mood (Banks and Dinges 2007; Oginska and Pokorski 2006; Scott et al. 2006; Selvi et al. 2007)	Impaired cognitive performance and ability to multi-task (Dinges et al. 1997; Lamond et al. 2007; Pilcher and Huffcutt 1996)	Drowsiness, micro-sleeps and unintended sleep (Basner et al. 2008a, b; Philip and Akerstedt 2006; Pilcher et al. 2000; Scott et al. 2007).
Depression and psychosis (Johnson et al. 2006; Kahn-Greene et al. 2007; Riemann and Voderholzer 2003; Sharma and Mazmanian 2003)	Impaired memory, attention and concentration (Chee and Chuah 2008; Dworak et al. 2007; Goder et al. 2007; Oken et al. 2006)	Bodily sensations of pain and cold (Kundermann et al. 2004; Landis et al. 1998; Roehrs et al. 2006)
Increased irritability, impulsivity and frustration (Dahl and Lewin 2002; Kelman 1999; Muecke 2005)	Impaired communication and decision-making skills (Baranski et al. 2007; Harrison and Horne 2000; Killgore et al. 2006a; Killgore et al. 2007; Lucidi et al. 2006)	Increased risk of cancer (Davis and Mirick 2006; Hansen 2006)
Increased risk-taking (Acheson et al. 2007; McKenna et al. 2007; O'Brien and Mindell 2005; Venkatraman et al. 2007)	Reduced creativity and productivity (Horne 1988; Jones and Harrison 2001; Killgore et al. 2008; Randazzo et al. 1998)	Metabolic abnormalities, cardiovascular disease and diabetes (Gangwisch et al. 2005; Knutson et al. 2007; Laposky et al. 2008; Maemura et al. 2007; Yang and Winkelman 2006; Young and Bray 2007)
Increased stimulant, sedative and alcohol abuse (Baranski and Pigeau 1997; Boivin et al. 2007; Killgore et al. 2006b; Roehrs and Roth 2001a, b)	Impaired motor performance (Kahol et al. 2008; Pilcher and Huffcutt 1996)	Reduced immunity to disease and viral infection (Irwin 2002; Lorton et al. 2006)
	Dissociation (Lynn et al. 2012)	Altered regulation of the HPA axis (Meerlo et al. 2008)

The effect of light on our sleep-wake rhythm

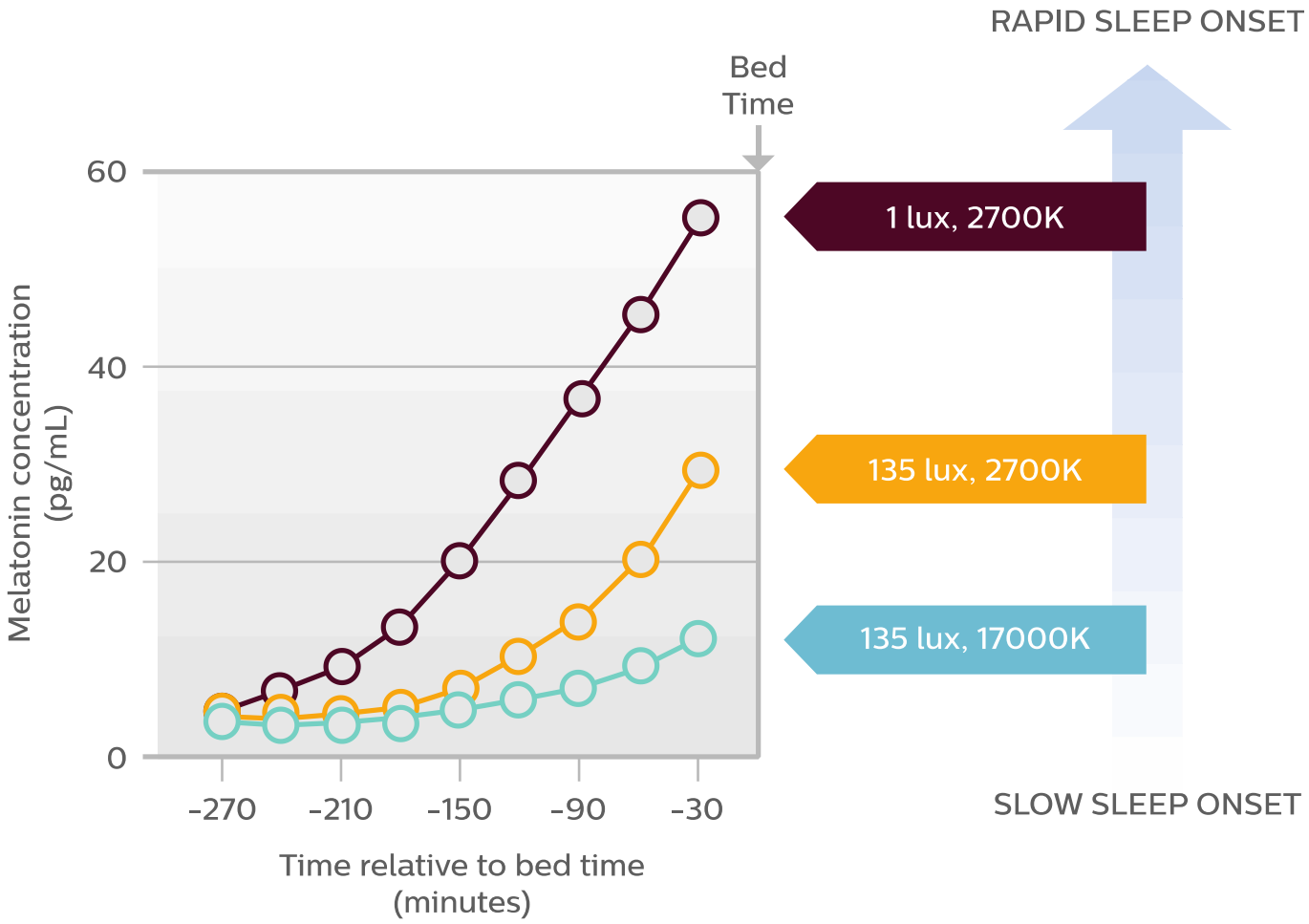
Light during the evening impairs sleep



Signify

The effect of light on our sleep-wake rhythm

Light during the evening impairs sleep

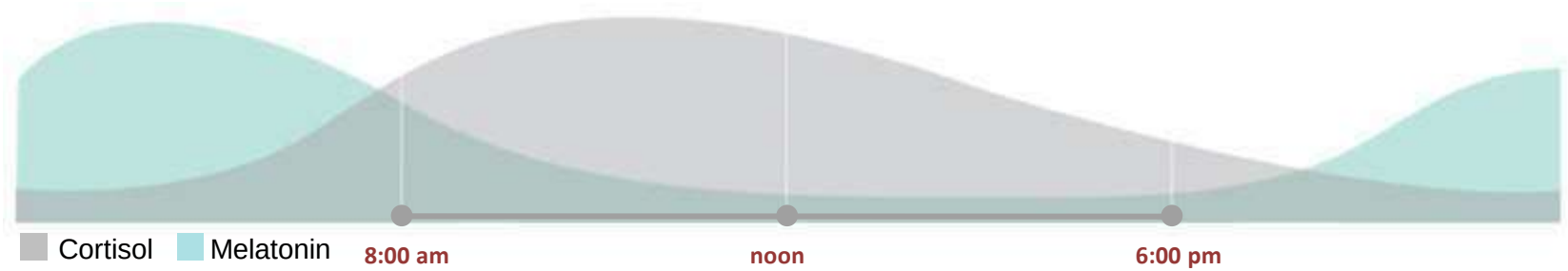


Santhi et al. *J.Pineal Res. 53 (1):47-59, 2011.*

Signify

The effect of light on our sleep-wake rhythm

Light in the morning wakes you up

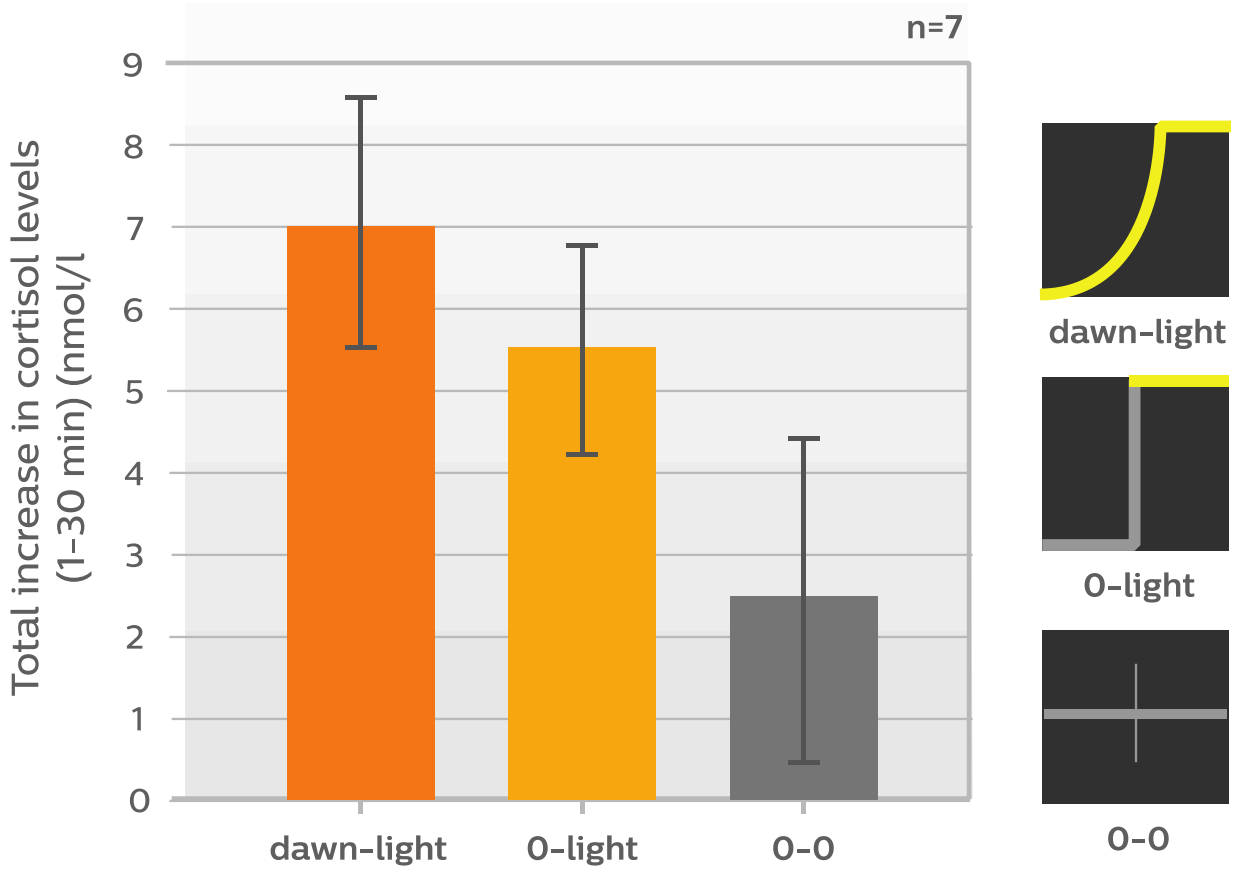


Signify

The effect of light on our sleep-wake rhythm

Light in the morning wakes you up

- reduces morning sleepiness and sleep inertia,
- increases cortisol & faster drop in distal skin temperature

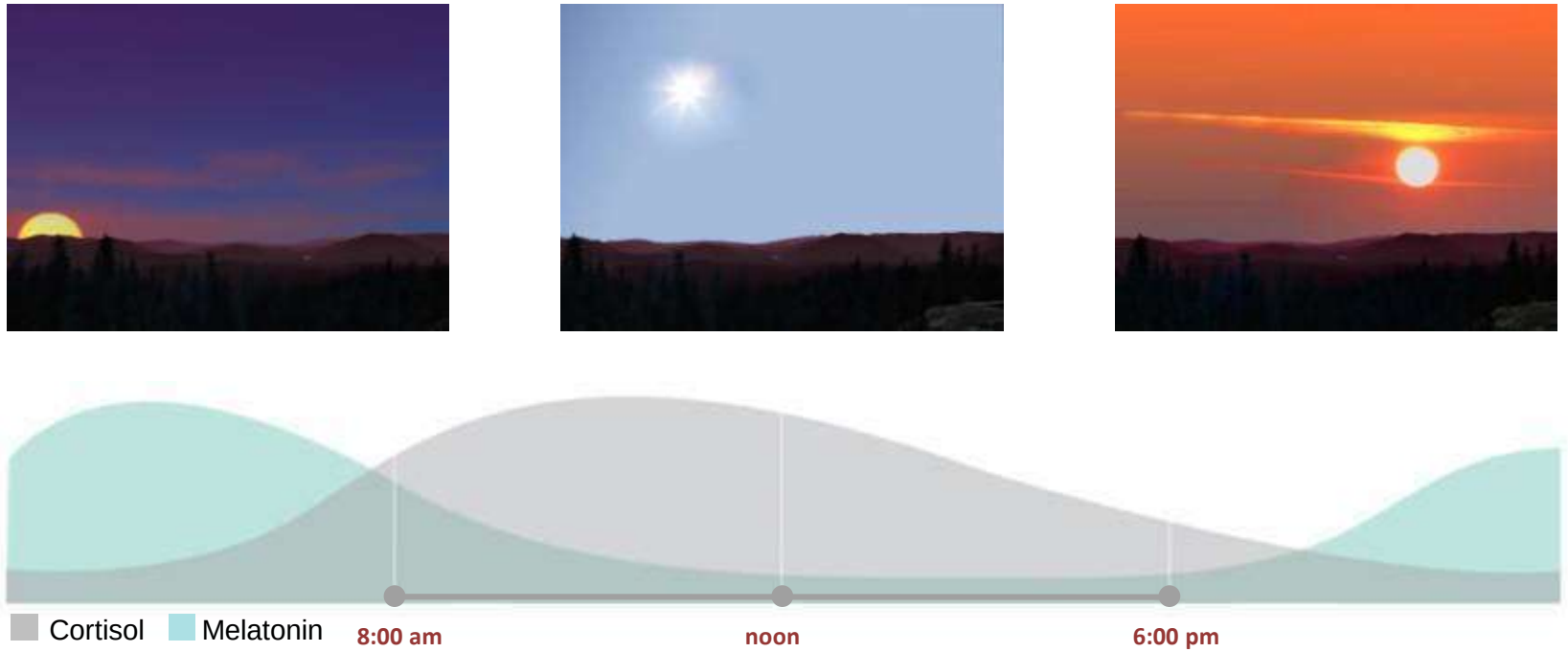


Van de Werken et al. J Sleep Res, 2010

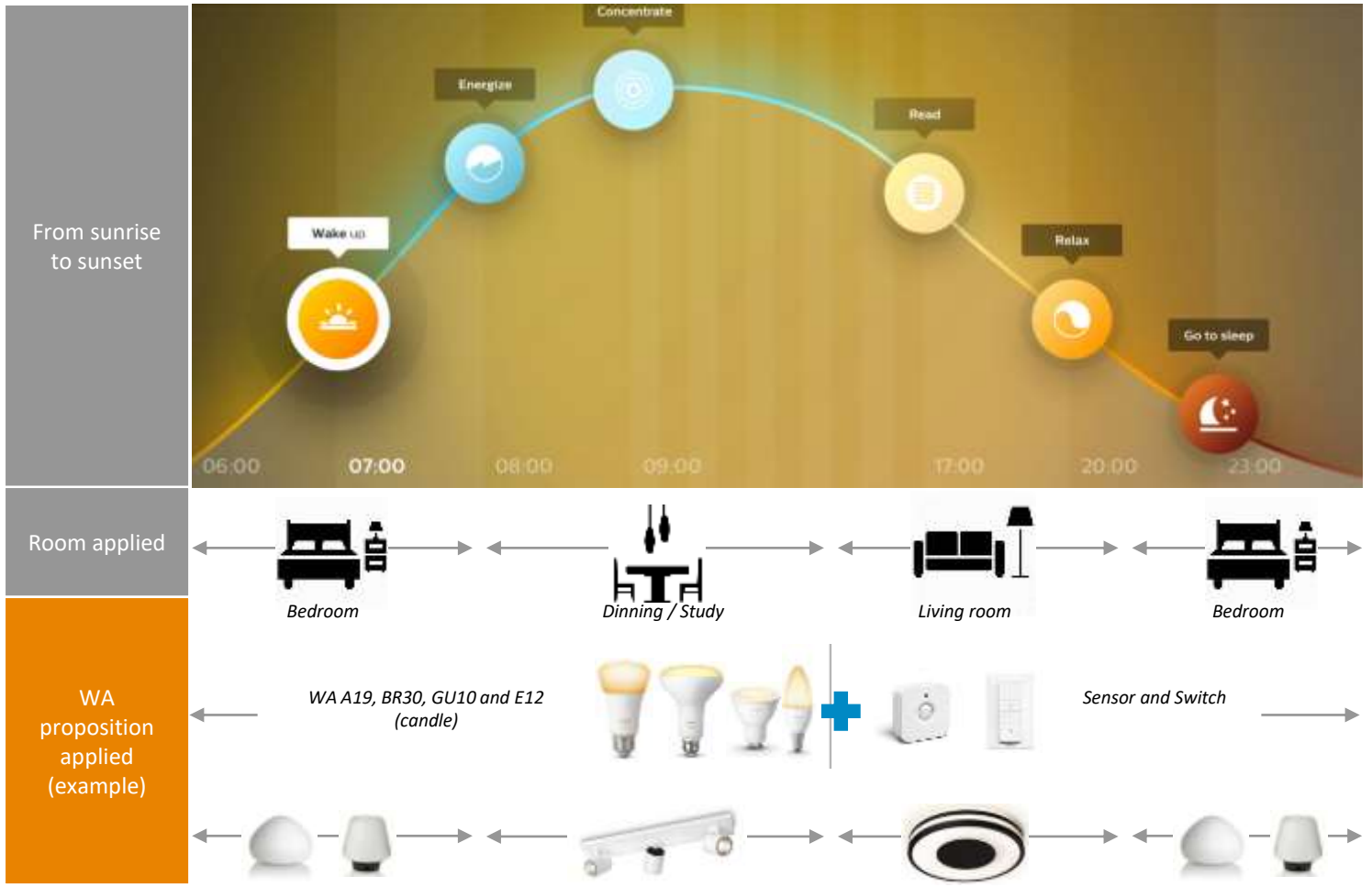
Signify

The effect of light on our sleep-wake rhythm

A sharp contrast between day and night can help regulate sleep patterns



Philips Hue White Ambiance:
Feel better with lights from sunrise to sunset

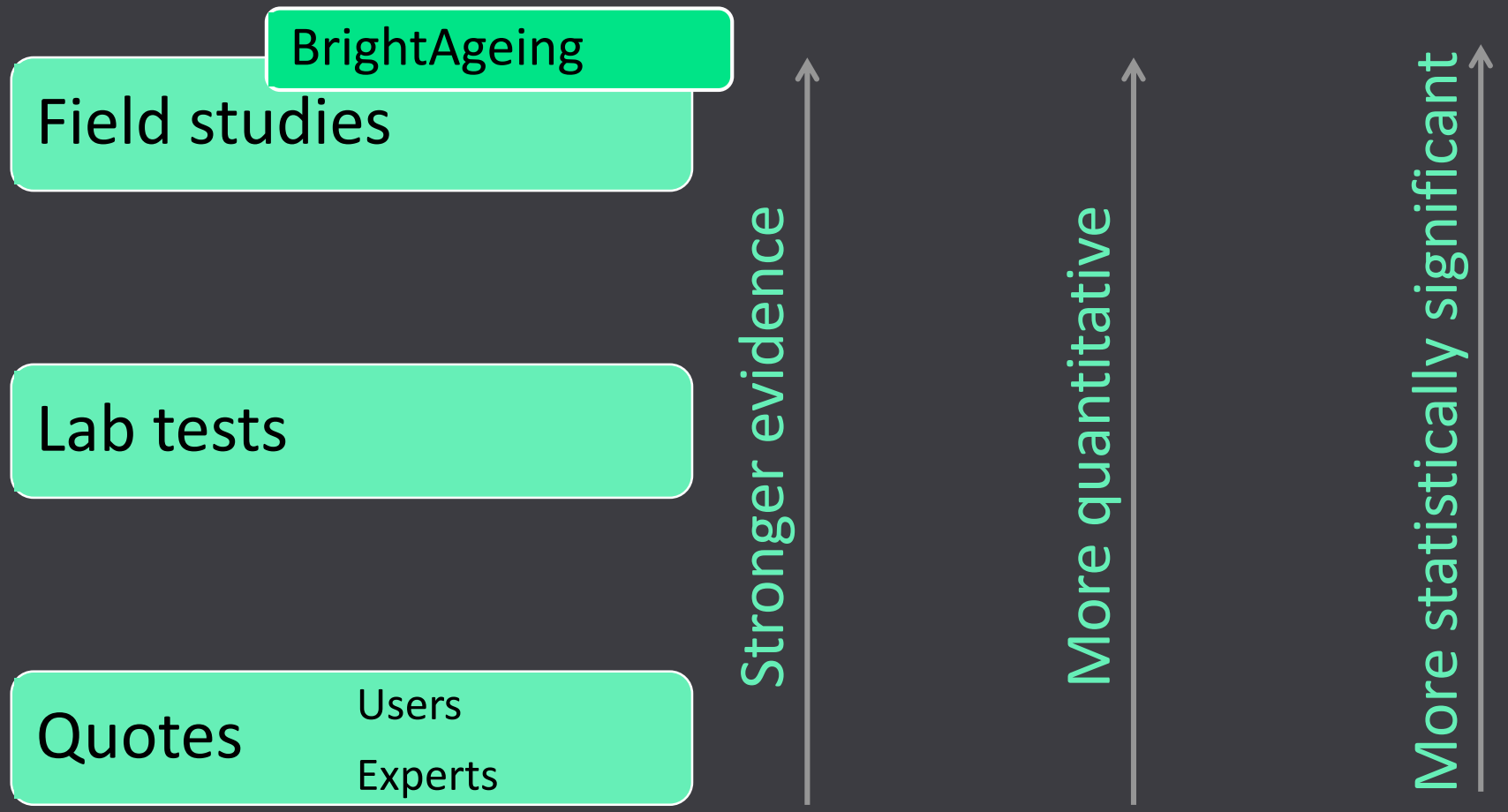


https://youtu.be/bL6KV03MJ8M

Signify

Our recent data-based home-placement studies

Various levels of evidence, depending on data



signify

2018: EIT Digital-funded project “BrightAgeing”: Well-being home placements

- European cooperation project
- 4 main partners + 3 subgrantees/subcontractors; incl. housing association and insurance company; Signify as Activity leader
- 4 Philips Hue home-placement studies in 3 countries
- https://www.eitdigital.eu/fileadmin/files/2018/factsheets/digital-wellbeing/BrightAgeing_Factsheet.pdf

Three types of well-being pilot studies done in 2018

1. **In Finland with public housing corporation**
   - Data from Philips Hue motion sensors

2. **In Germany with housing association**
   - Physiological data from wearables

3. **In the Netherlands with insurance company**
   - Surveys

Summary of data-based results from pilots in Finland

BrightAgeing 2017

2017 Pilot in Helsinki by Philips Lighting and Forum Virium Helsinki Oy, Tieto Oyj and city of Helsinki Service Centre

Home placement of connected lighting & motion sensors

20 elderly homes in Helsinki

https://eit.europa.eu/news-events/news/eit-digital-bringing-light-elderly-peoples-lives-bright-ageing

https://www.eitdigital.eu/fileadmin/files/2017/newsroom/publications/wellbeing/BrightAgeing_Factsheet_March2017.pdf

BrightAgeing

Digital Wellbeing

BrightAgeing

Lighting beyond illumination

BrightAgeing is offering innovative solutions based on a connected lighting system in order to provide lighting conditions that match the specific needs of elderly people and enable them to live independently at home longer.

The BrightAgeing project develops innovative solutions that enable elderly people to live independently at home longer. For this purpose, a smart lighting and sensor system will be installed in 20 elderly homes in Helsinki and a data analytics service will be developed. The aim of the pilot is to obtain the proof points that are needed to commercialize the system and service, improving wellbeing while resulting in cost savings for home care.

Wireless motion sensors can detect movements and automatically provide the right light at the right moment. Note that poor lighting is one of the main causes for domestic accidents of seniors. Besides, elderly people need 3-10 times more light compared to an average person. Further, the connected lighting system could also give visual alerts (e.g. reminders for medication).

eit Digital

PHILIPS Lighting

City of Helsinki

FORUM VIRIUM HELSINKI

Palvelukeskus Helsinki

eitdigital.eu

@EIT_Digital

Driving Europe's Digital Transformation

BrightAgeing 2017: Video about joint pilot with the Home Care Centre of the City of Helsinki

https://youtu.be/I40GehF22Os

Data analysis conclusions from pilot in Finland in 2018 (also confirmed by surveys)

- Hue Nightlight: People feel more confident to go out of bed to do their night routines, also because they are less worried not being able to fall asleep again. They go more often but do it more efficiently; total time out of bed did not increase.

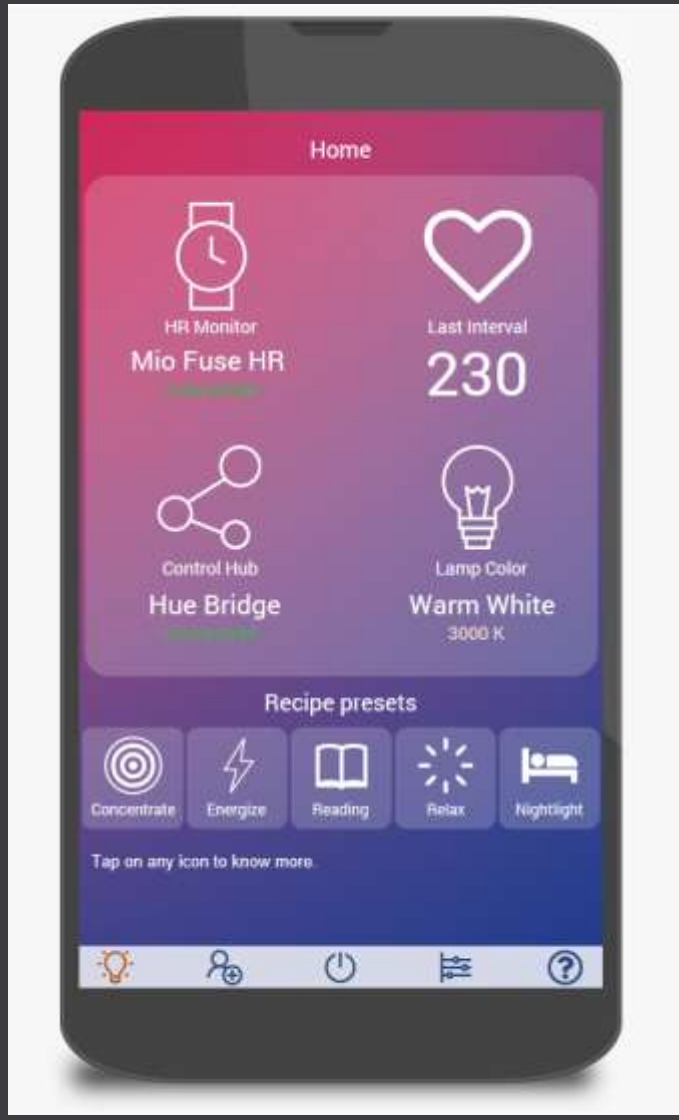
Video about recent joint pilot in Helsinki

https://youtu.be/NaVCezJEVBQ

Summary of data-based results from pilot in Germany

Study in Berlin with housing corporation *mainstream market*

- Together with association of housing corporations (with ~1.1. million homes in Berlin Brandenburg)
- Physiological data from wearables
- Dedicated app for pilot, leading to commercial app
- Website participants, website administrators, flyer



Pilot in Germany – setup

https://youtu.be/oWlBLmlkIo8

Data analysis conclusions from pilot in Germany

(p<=0.05)

- People slept more peacefully when using Philips Hue White Ambiance (stress level and heart rate during sleep period decreased)
- People woke up calmer with warm Philips Hue light (lower heart rate)

(p<=0.15)

- People woke up more energized with cold Philips Hue light (higher stress level and heart rate)
- People were more relaxed before falling asleep when using Philips Hue White Ambiance (lower heart rate)

Summary of results from pilots in the Netherlands

Video about recent joint pilot with Zilveren Kruis (Achmea)

Some key points to conclude

1. Lighting is everywhere; enabled by connectivity it can deliver ever greater value beyond illumination.

2. Light surrounding us is more than the opposite of dark: it allows us to see, enables to experience the environment, regulates our biological clock, etc.

3. Light in the morning wakes you up,
   (wrong) light in the evening impairs sleep,
   bright light during the day helps you to feel active and also to sleep well during the night.

4. For the first time objective, data-based proof points for physiological effects of Hue light recipes have been obtained.

signify

Thanks to all BrightAgeing partners!

FORUM VIRIUM HELSINKI

Setlementti asunnot
THE COMMUNITY DEVELOPER

WBM.


signify