Does low intensity light at night (low-LAN) affect human body temperature?

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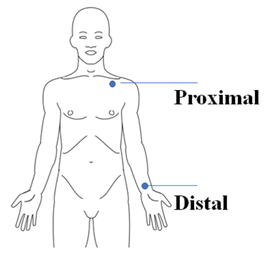
Introduction

Artificial light at night has multiple effects on humans, animals and plants [1]. In humans, light affects the circadian system, modulates wakefulness and sleep [2], and affects other physiological functions, even with short exposure durations [3] and at very low intensities [4].Thermoregulation and sleep regulation are integrated in the pre-optic anterior hypothalamus (POAH). This is likely to explain why sleep disturbances are associated with alterations of body temperature, and vice versa, why temperature dysregulation (i.e., fever) is associated to sleep disturbances [5]. Bright light has been shown to affect both sleep and thermoregulation in humans through non-visual pathways involving melanopsin ganglion cells (iPRGCs), but whereas low intensities of light at night (LAN) acutely impact sleep structure and body temperature (in sleeping subjects), is unknown [6]. One aim of our study is to explore whether low-LAN affect human body temperature during sleep.

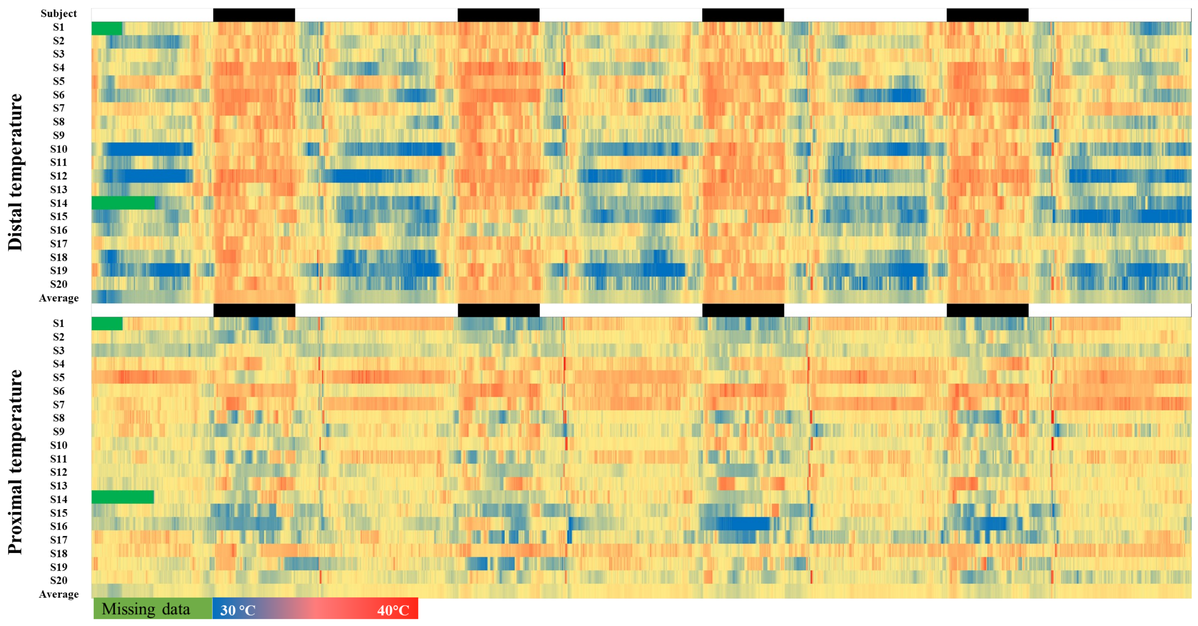
Methods

A total of 20 healthy volunteers were enrolled in a 5-days protocol in the laboratory (see Figure), they were sleeping 8 hours at night in one of four randomized light conditions during sleep (0, 3, 8 and 20 lux). Skin temperature was recorded continuously over 108 hours (from the beginning of day 1 to the end of day 5, 2 min sampling rate) via 2 temperature sensors (i-Buttons, Maxim) placed on the infra-clavicular area and the wrist of the non-dominant hand. The distal-proximal gradient (DPG) was calculated using the formula: DPG = distal - proximal skin temperatures. All temperature data were z-transformed per individual and data checked for outliers. Linear mixed model is used for statistical analysis.

age(years)	24.2±3.3
BMI (kg/m^2)	22.2±2.2
PSQI	3.2±1.5
Bed time	23:01
Wake time	07:23
Mid sleep time	03:02
Sleep duration (h)	08:00



Results



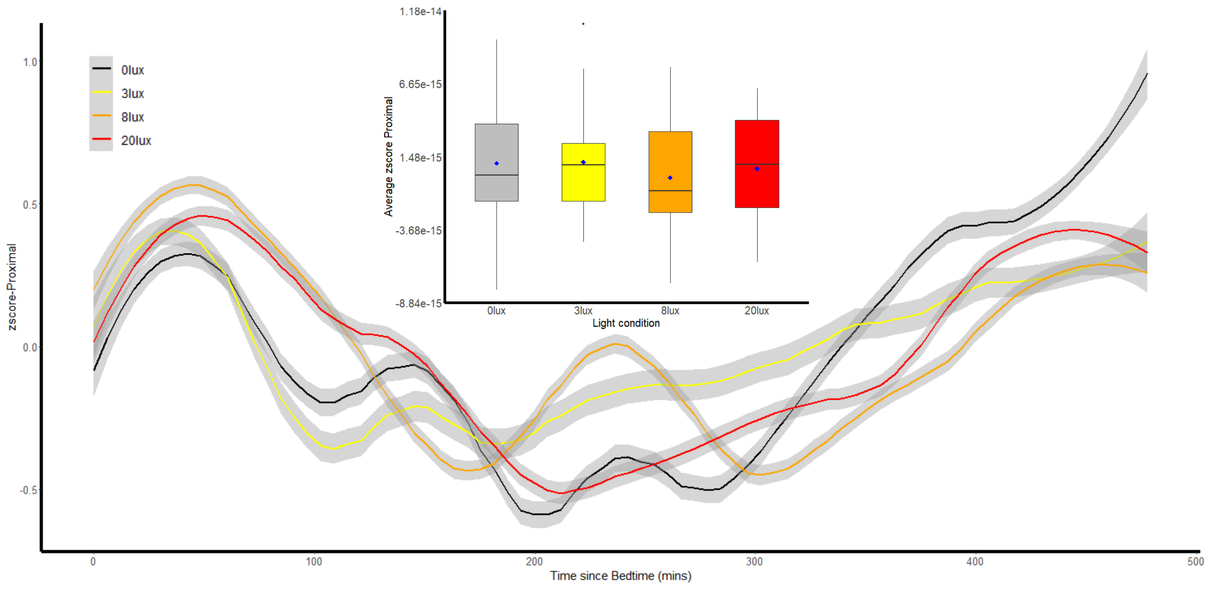


Figure 1: **Heatmap of distal and proximal skin temperature over 5 Days**. Each row represents a subject from Day 1 to Day 5, the last row represents the average of 20 subjects. Distal skin temperature increases during the night and decreases during the day. The change in proximal skin temperature is opposite, it decreases during the night and increases during the day.

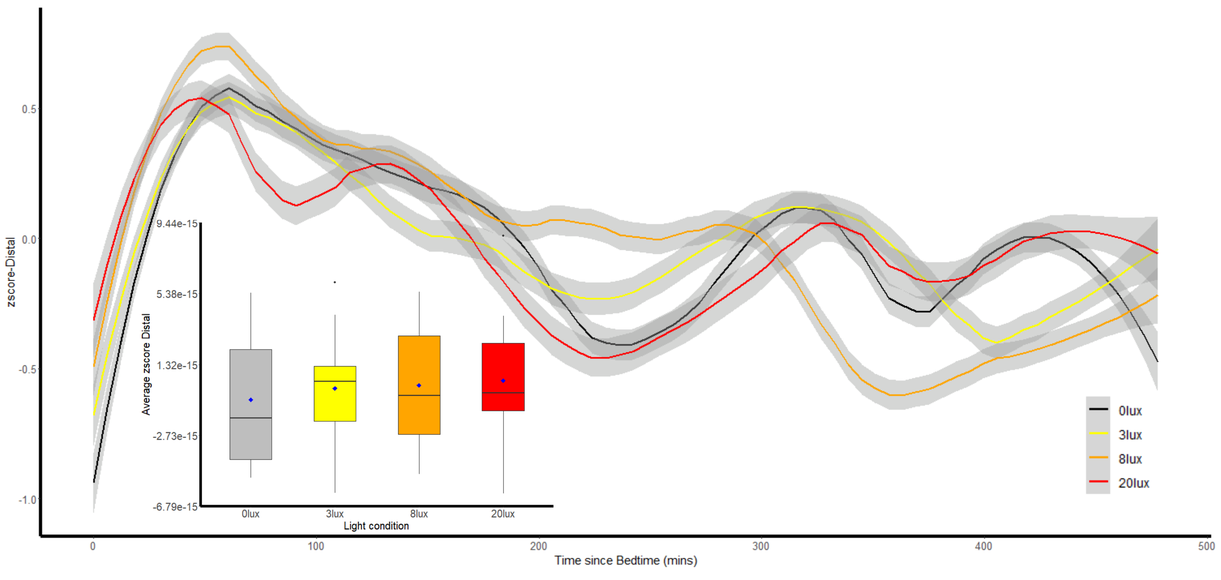


Figure 3: **Distal skin temperature profiles at night under 4 light conditions**. There is a light effect at 3 and 20 lux compared with the 0 lux condition (3lux:p<0.001. 20lux:p=0.0016, Model: lme (zscore-Distal ~ light + time + day + light * time + light * day + day * time + light * time * day , random=~1|subject/light, method="ML")). Profiles are smoothed (loess). Data in the insert figure are mean temperatures at night ± 95%CI**.**

Figure 2: **Proximal skin temperature profiles at night under 4 light conditions**. Temperature is significantly decreased during the 8 lux night compared to the 0 lux night (p<0.001, model: lme (zscore-Proximal ~ light + time + day + light * time + light * day + day * time + light * time * day , random=~1| subject /light, method="ML")). Profiles are smoothed (loess). Data in the insert figure are mean temperatures at night ± 95% CI**.**

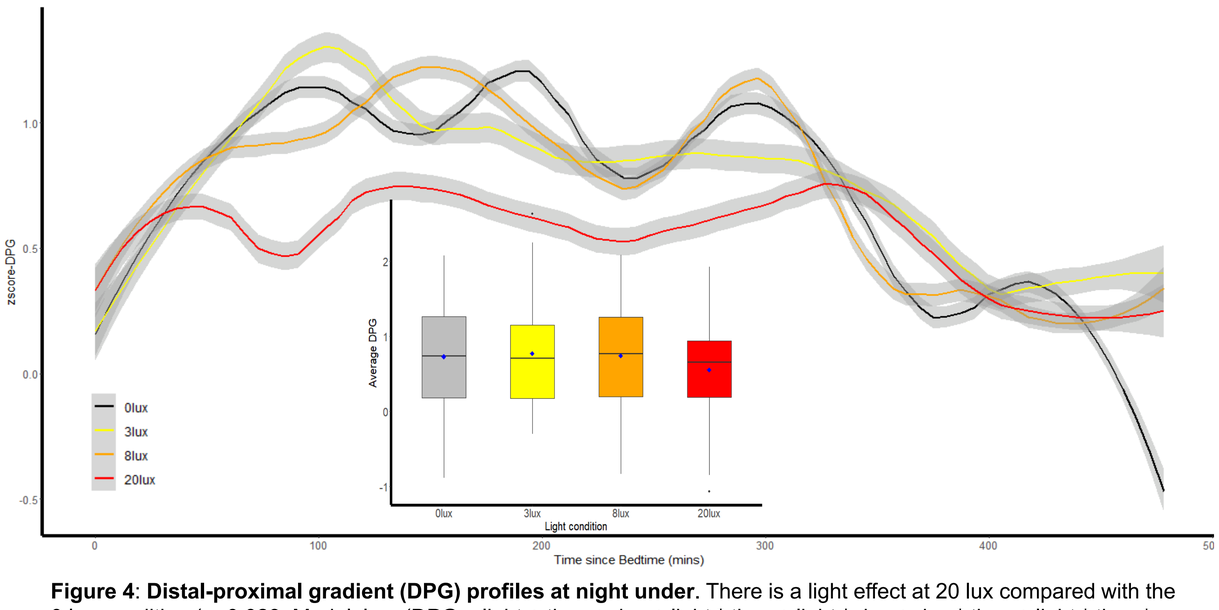


Figure 4: **Distal-proximal gradient (DPG) profiles at night under**. There is a light effect at 20 lux compared with the 0 lux condition (p=0.029, Model: lme (DPG ~ light + time + day + light * time + light * day + day * time + light * time * day , random=~1| subject /light, method="ML")). Profiles are smoothed (loess). Data in the insert figure are mean DPGs at night ± 95%CI**.**

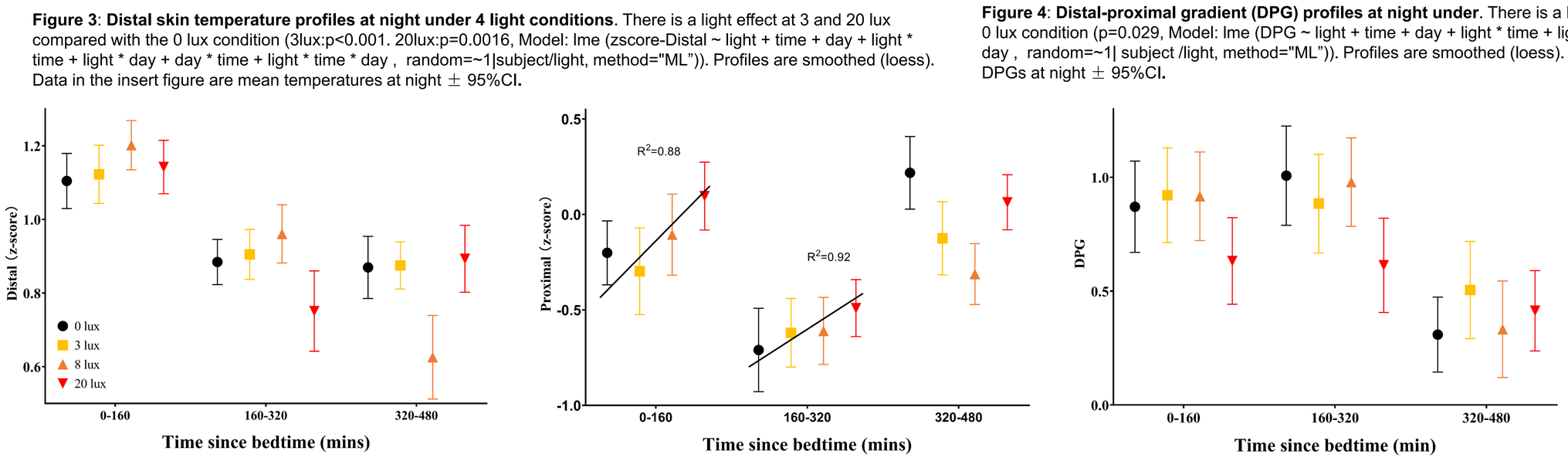


Figure 5: Relationships between nocturnal light intensity and skin temperature during sleep. There is a linear relationship between light intensity and proximal skin temperature during the first and second thirds of the nights. Data shown are mean ± SEM**.**

Conclusion

Altogether, our preliminary results suggest that low light intensities during nocturnal sleep (3~20 lux) impact both proximal and distal body temperatures at night. Further analyses are underway to clarify whether this effect of light on temperature results from an alteration of sleep structure, or on the opposite, whether the temperature alteration might affect sleep.

Reference

[1] Falcón J et al. Frontiers Neurosci. (2020) [2] Abhishek S P et al. Clocks & Sleep. (2019) [3] Abhishek S P et al. Frontiers Neurosci. (2019) [4] Abhishek S P et al. The Journal of Pineal Research. (2019) [5] Krauchi K et al. Frontiers in Bioscience-Landmark. (2010) [6] Cajochen C et al. The Journal of Clinical Endocrinology & Metabolism. (2004)

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