

Background

In industrialized societies people spend most of the day-time indoors and are exposed to excessive light-at-night a situation that causes misalignment of individual's physiology with the environment. This misalignment may affect emotional welfare, cognitive performances and even participation in everyday living activities. The goal of the current, proof-of-concept, home-based study, was to test the effects of a daily use of a bedside lamp simulating sunrise combined with light hygiene, on cognitive-emotional performance and participation measures (Maruani and Geoffroy, 2019, Roenneberg et al., 2007).

Methods

Participants: 21 young, healthy University students (14 women, age: 24.5±4.6). Inclusion criteria: Not shift workers, at least six hours of night sleep, no use of medications, no diagnosis of neurological or psychiatric condition, no learning disabilities, ADHD, communication disorder, normal/corrected eyesight, no COVID at least a month before and during the experiment.

Participants were asked to set-up the time of the ArtDawn lamp (Lumie Zest model) each morning to the time of their choice. 30 min before the scheduled wake up, the lamp started to glow and gradually reaches 500 LUX at 0.5m distance

Baseline: participants kept with their day-to-day routines.

Sleep Hygiene (dark nights + individual recommendations from occupational therapist): at the beginning of week 2 participants were instructed to minimize the intrusion of any artificial light into the bedroom to minimum.

ArtDawn (bright beginnings) intervention: participants were provided with a lamp simulating sunrise (ArtDawn), to position at bedside.

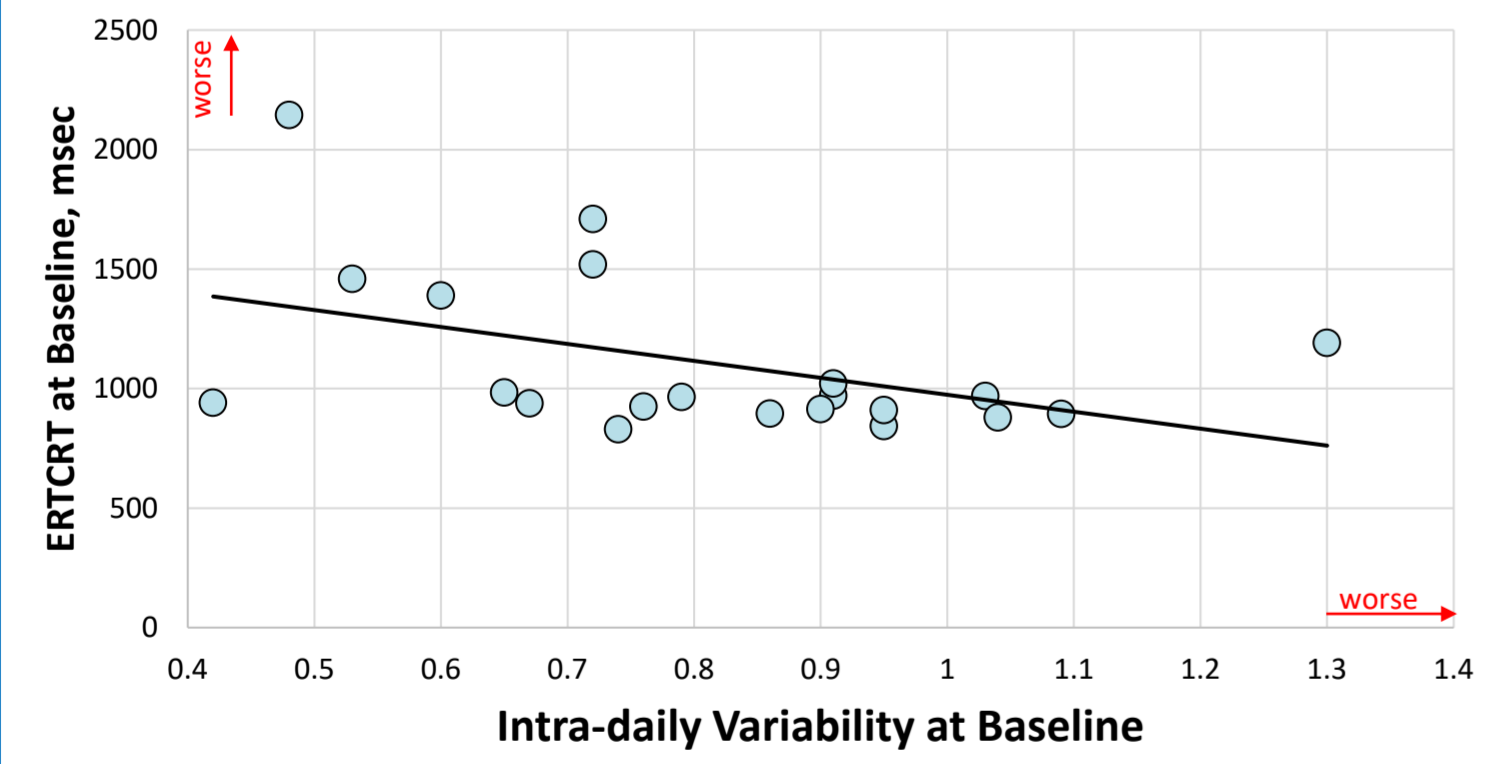
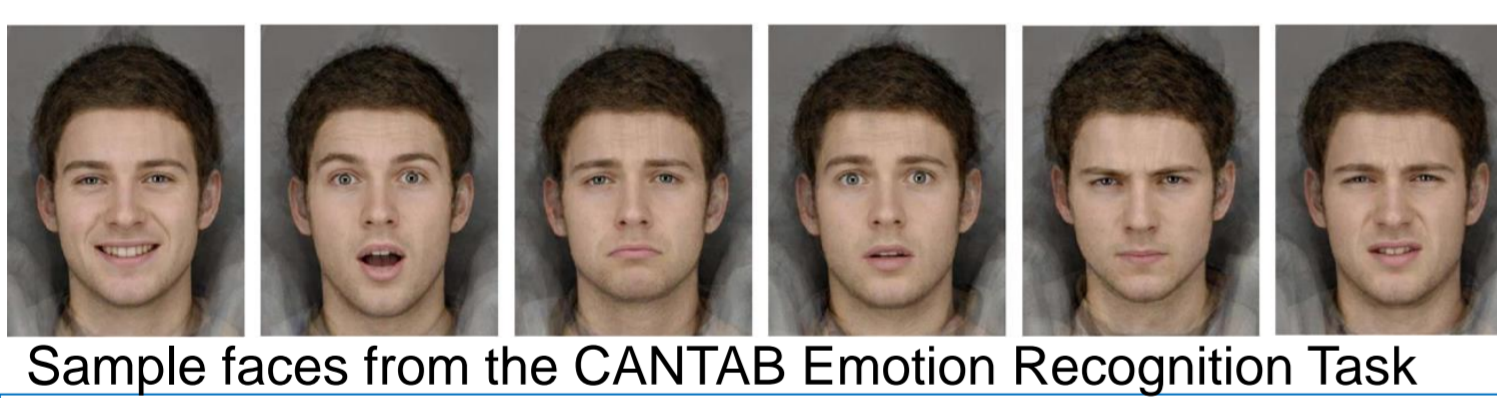
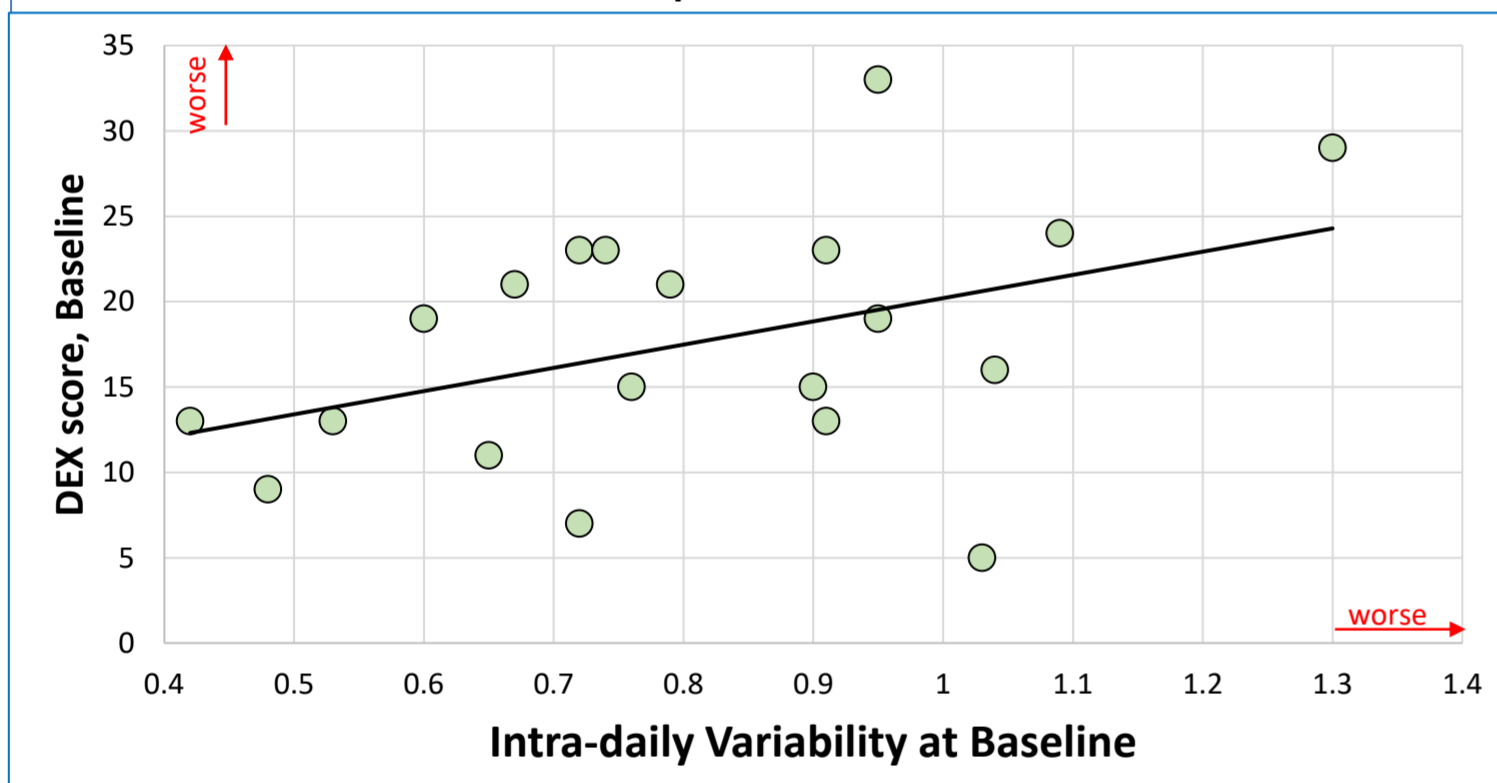


	Week 1 Baseline	Week 2 Sleep hygiene	Weeks 3 & 4 ArtDawn Intervention
Actigraphy + Sleep Diary			
Sleep Hygiene (dark nights+)			
ArtDawn (bright beginnings)			
Questionnaires (Ox-PAQ, DEX, DASS-21)			
Cognitive tests (CANTAB)			
	NPCRA		NPCRA

During the 4-weeks of the experiment, participants wore an MotionWatch 8 **actigraph** and completed a **daily sleep diary**. **NPCRA variables** of circadian rhythm (IS, IV, L5, M10, RA) were calculated for the first eight the last eight days. Participants had three test-meetings at the beginning, middle and the end of the experiment at their homes during which they filled in digitalized **clinical questionnaires: participation in activities of daily living (Ox-PAQ), executive dysfunctions symptoms (DEX), and depression, anxiety and stress symptoms (DASS-21)**. Computerized cognitive tests (**CANTAB**) were used to test attention and memory performance as well as motor speed, executive functions and emotional and social cognition. **The individual differences (Δ)** between the Baseline and ArtDawn intervention **phases** were calculated for the NPCRA parameters. As well, deltas were calculated Hygiene and ArtDawn intervention and Total periods test-points questionnaires scores (Ox-PAQ, DEX, DASS-21) and CANTAB tests (**Emotion Recognition Task (ERT)**, **Rapid Visual Information Processing task (RVP)**, **Stop Signal Task (SST)** and **Paired Associates Learning task (PAL)**). Within-subject GLM/Wilcoxon tests and Pearson/Spearman correlations were used in data analysis.

Results

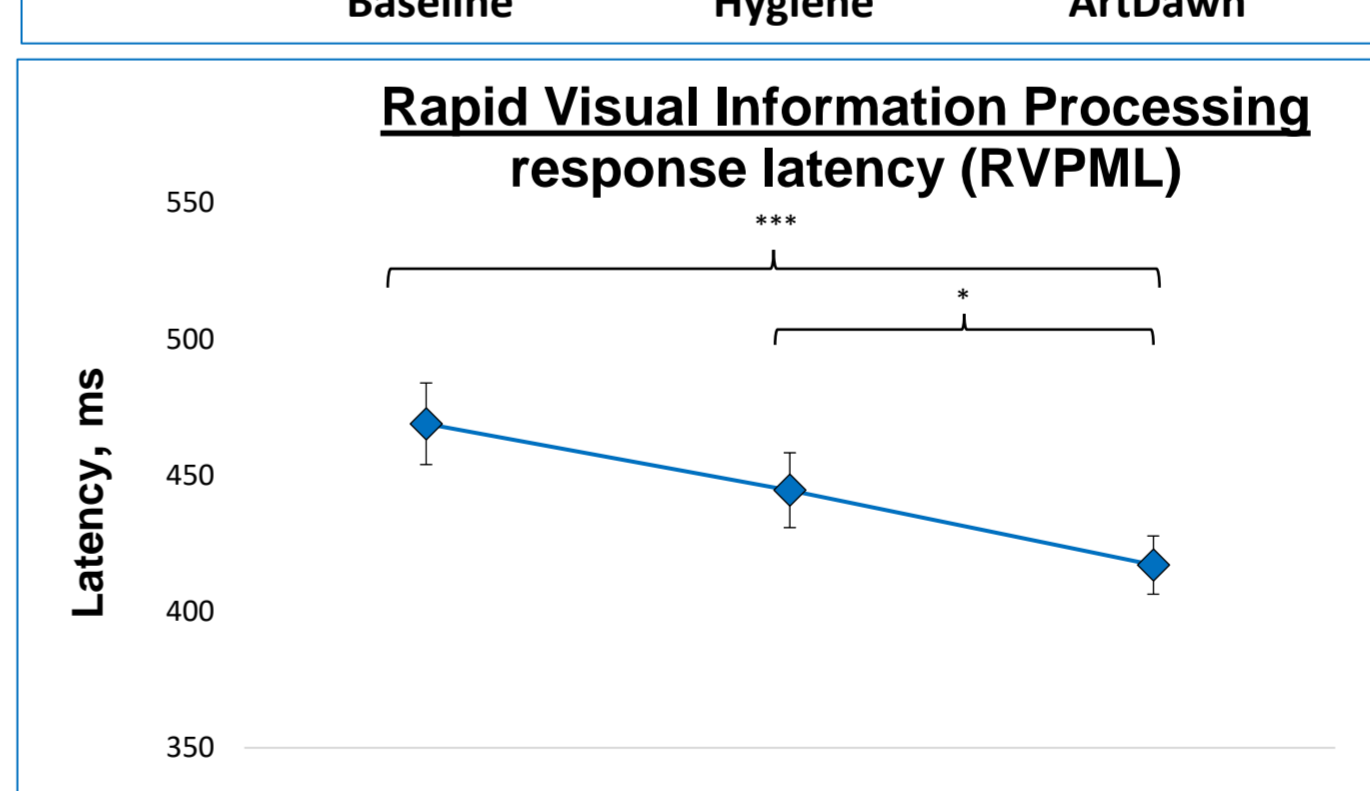
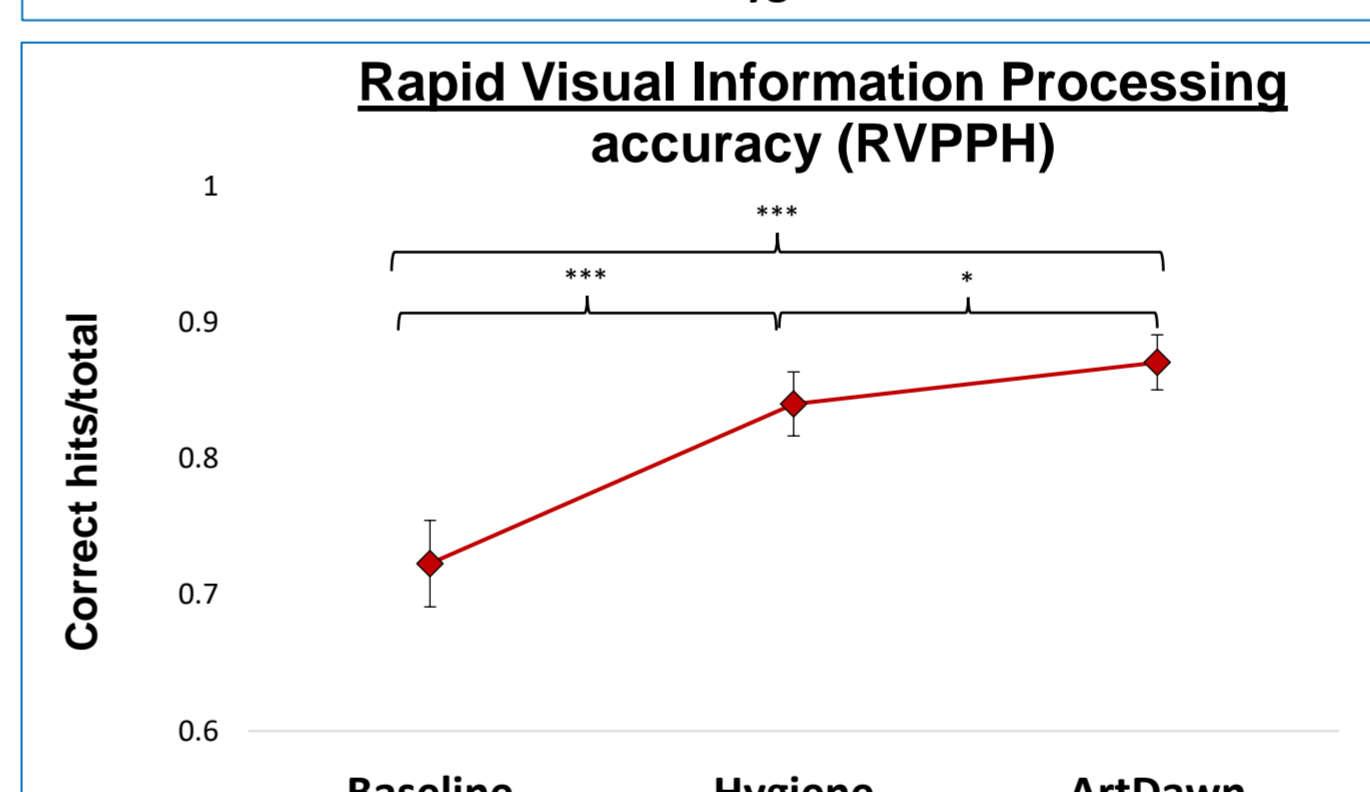
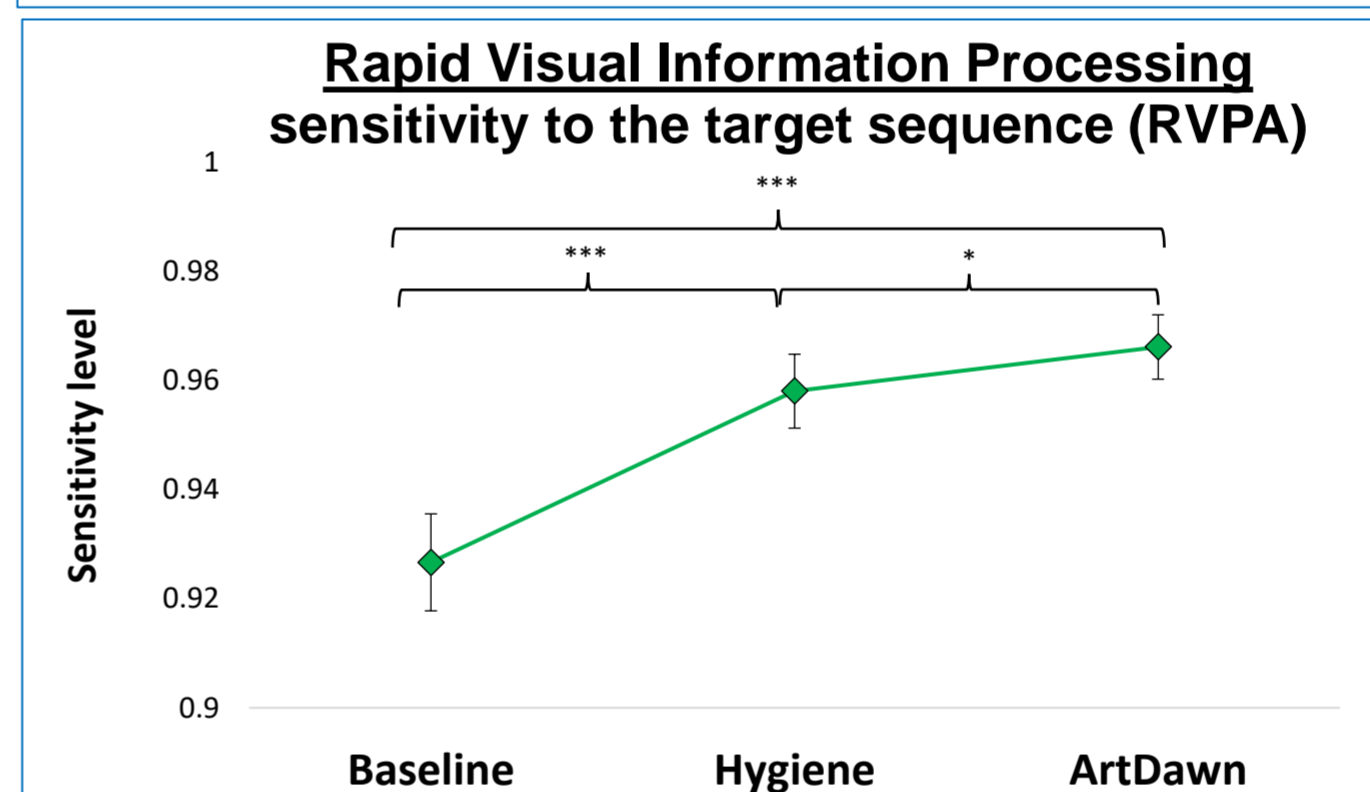
Fragmentation of activity-rest periods at Baseline was associated with more symptoms of executive dysfunction (DEX: $\rho_s = 0.45^{**}$), slower emotion recognition (ERTCRT: $\rho_p = -0.44^{**}$) and inferior response inhibition performance (SSTMRTG: $\rho_p = 0.48^{**}$, not shown)



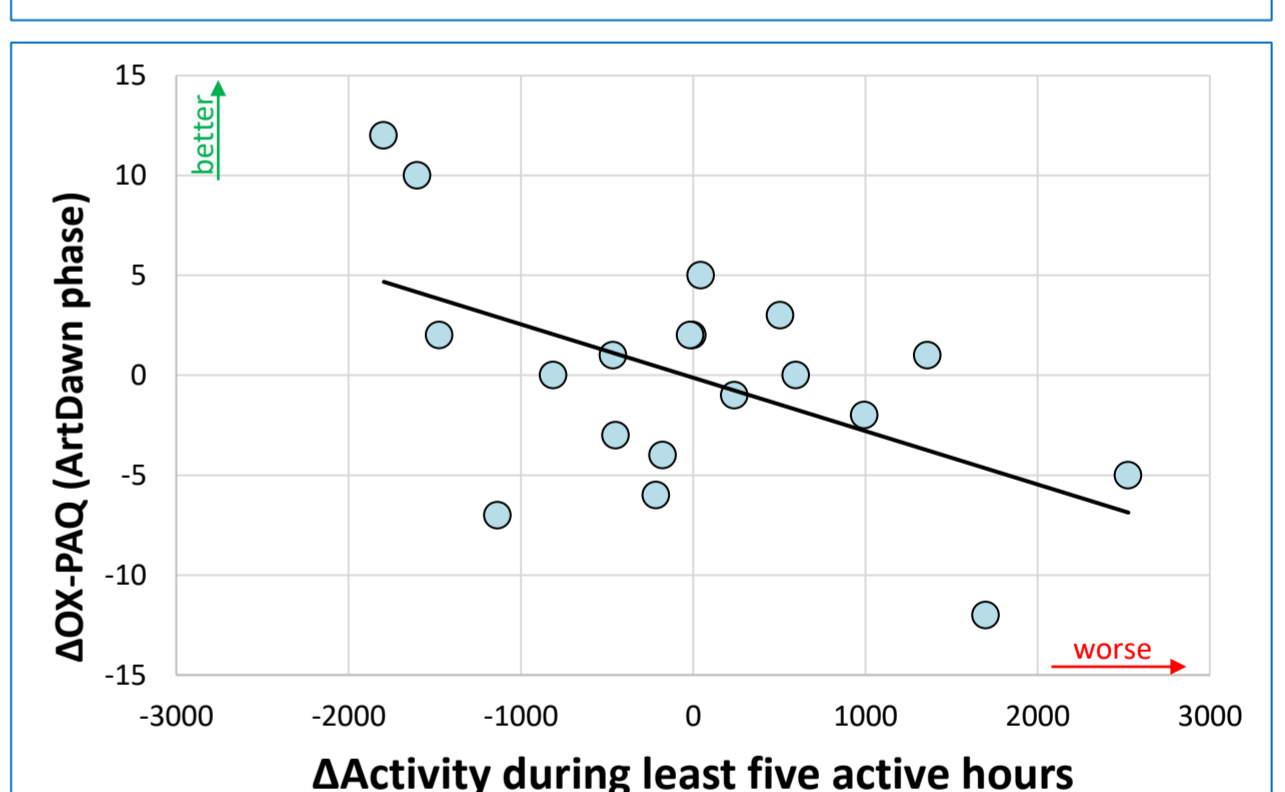
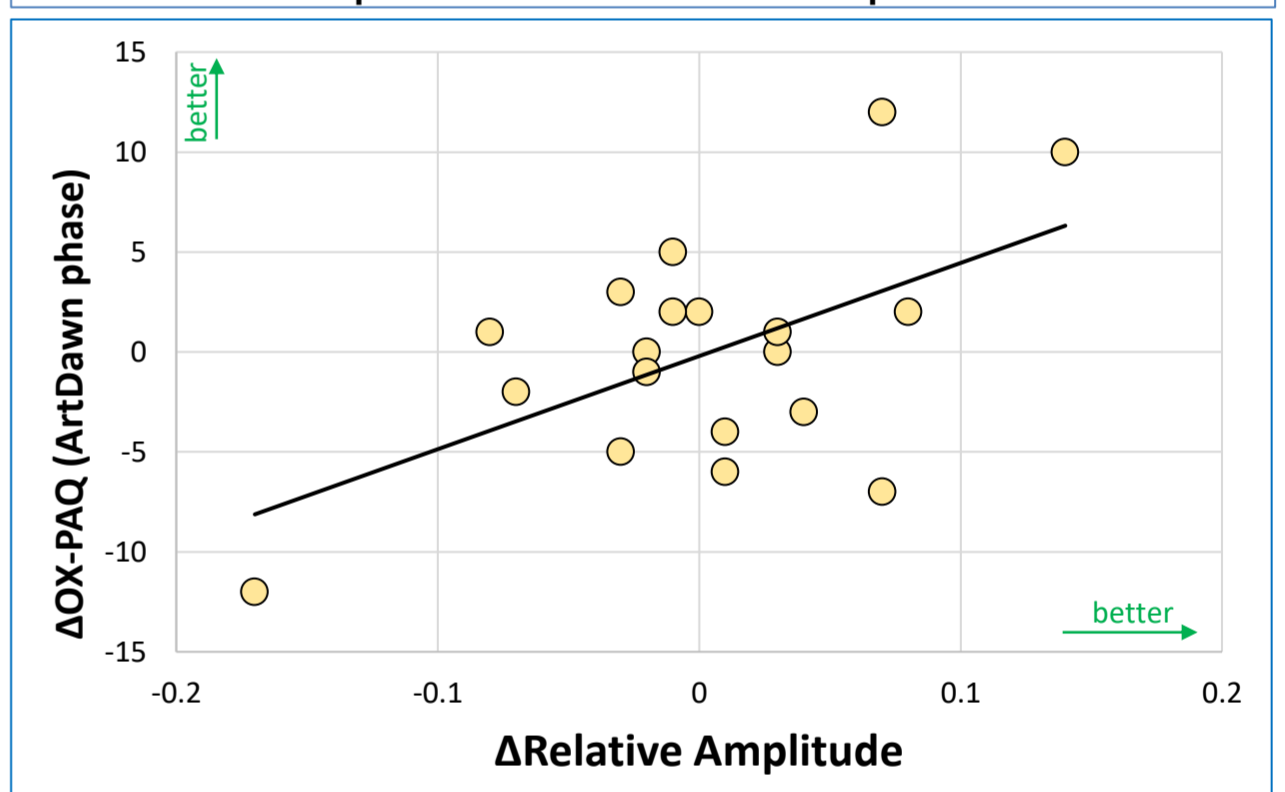
A multitude of cognitive-emotional scores improved across the Light Hygiene, the ArtDawn and the Total experimental periods. *No decrements were observed!

Light Hygiene	ArtDawn
DEX ($p=0.02$) Ox-PAQ ($p<0.01$) <u>Visual learning and memory</u> PALFAMS ($p=0.04$) PALMETS ($p=0.08$) PALTE ($p=0.03$) <u>Sustained attention</u> RVPA ($p<0.01$) RVPML ($p<0.01$) RVPPH ($p<0.01$)	<u>Sustained attention</u> RVPA ($p<0.01$) RVPML ($p<0.01$) RVPPH ($p=0.04$)
Total improvement	
<u>Emotion Recognition</u> ERTCRT ($p<0.01$) ETRT ($p<0.01$) <u>Visual learning and memory</u> PALFAMS ($p=0.03$) PALMETS ($p=0.05$) PALTE ($p=0.04$) <u>Sustained attention</u> RVPA ($p<0.01$) RVPPH ($p<0.01$) <u>Response inhibition</u> SSTMRTG ($p<0.01$)	<u>Questionnaires</u> DEX ($p=0.05$) Ox-PAQ ($p=0.04$) But... no significant changes in the Circadian Rhythm variables were observed across the intervention period on the group level.

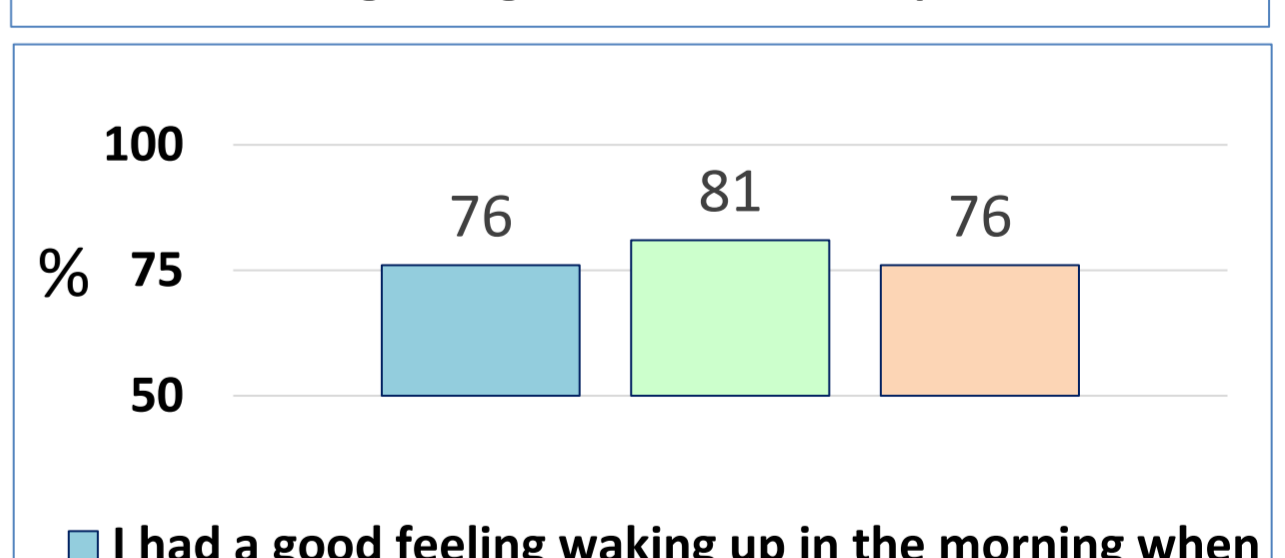
Sustained attention showed selective sensitivity to the ArtDawn intervention in all measures.



Significant correlation between ΔOx-PAQ and ΔRA ($\rho_p = 0.57^{**}$) and ΔL5 ($\rho_p = -0.54^{**}$)



Overall, excellent user experience was reported regarding the ArtDawn lamp.



Conclusions

Our results suggest that the ArtDawn intervention combined with Light Hygiene improves participation in daily activities as well as a multitude of cognitive-emotional variables in young healthy adults with no sleep deficit. The core executive ability of sustained attention was specifically sensitive to the ArtDawn intervention. Although no significant changes in the Circadian Rhythm variables were observed across the experimental period on the group level, on the individual level positive changes in the Relative Amplitude and the level of activity during least active 5 hours correlated with the gains in the Participation score. Overall, excellent user experience was reported regarding the ArtDawn lamp.

Altogether, this proof-of-concept study contributes to the development of long-term self-administrated photobiomodulation protocols combining usability and efficiency.

References

- Maruani, J. & Geoffroy P. A. (2019). Bright Light as a Personalized Precision Treatment of Mood Disorders. *Frontiers in psychiatry* 10: 85. doi: 10.3389/fpsy.2019.00085.
 Roenneberg, T., Kumar, C. J., & Mellow, M. (2007). The human circadian clock entrains to sun time, *Current biology*, 17(2):R44-5. doi: 10.1016/j.cub.2006.12.011