

## INTRODUCTION

Sleep and metabolism are essential physiological processes regulated by the circadian system. Several studies have shown a close relationship between sleep patterns and food intake [1-2]. In fact, both interoception (hunger or satiety) and exteroception (vision, taste, odor, etc.) are crucial factors that control food intake [3]. Previous studies have investigated the role of sleep and the circadian system in the regulation of energy expenditure, metabolism, and eating behavior [4], but the mechanisms and biological systems involved remain unclear. Light has been shown to affect the circadian system and certain physiological functions [5], and the aim of this study was to investigate how nocturnal light exposure affects interoception of food intake and its diurnal variations.

## MATERIALS AND METHODS

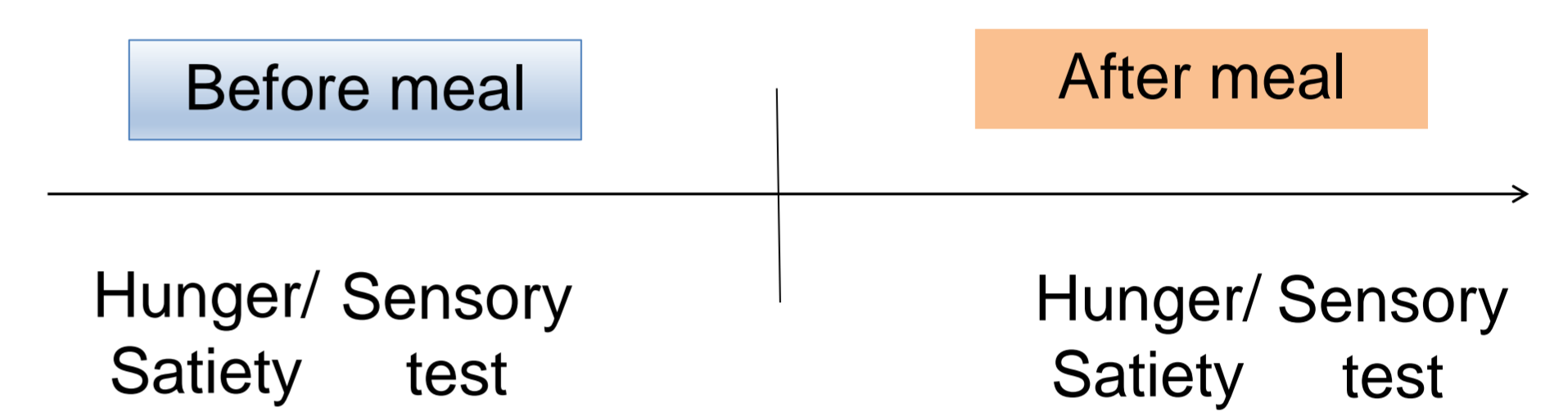
- Protocol: Temporal and social isolation, 5 consecutive days and 4 nights in the laboratory, sensory alliesthesia evaluated before/after each of the 14 meals per participant.
- Participants: 20 males, 20-35 (24.2±3.3) years old, healthy, not obese.
- Independent variable: Nocturnal light, either 0/3/8/20 lux during the 8-h night, distributed in a Latin square design, 90 lux during the day, sensory measurement (before/after each meal) by using food stimuli (olfactory/visual).
- Dependent variable: Interoception (hunger/satiety) and exteroception (sensory reward responses: liking/wanting/familiarity / disgusting), using a visual analog scale.
- Olfactory and visual stimuli: 4 aromas and 4 corresponding food images for breakfast and 10 aromas and 10 food images for lunch and dinner.

### Protocol of 14 consecutive meals over 5 days

	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	
Day 1	†				*							*													
Day 2	*				*							*													
Day 3	*				*							*													
Day 4	*				*							*													
Day 5	*				*							*													

\* Hunger and satiety, sensory (olfactory, visual) test, before and after each meal

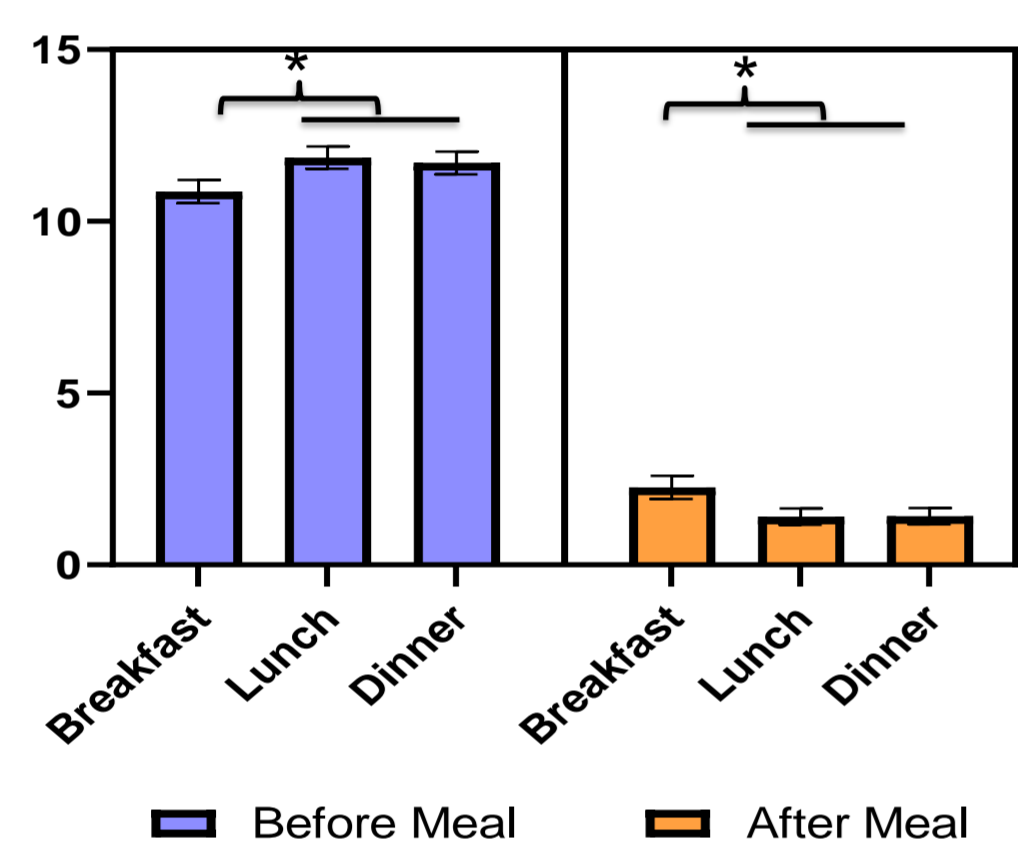
Age (years)	24.2±3.3
BMI (kg/m <sup>2</sup> )	22.2±2.2
PSQI	3.2±1.5
Bed time	23:01
Wake time	07:23
Mid sleep	03:02
Sleep duration	08:00



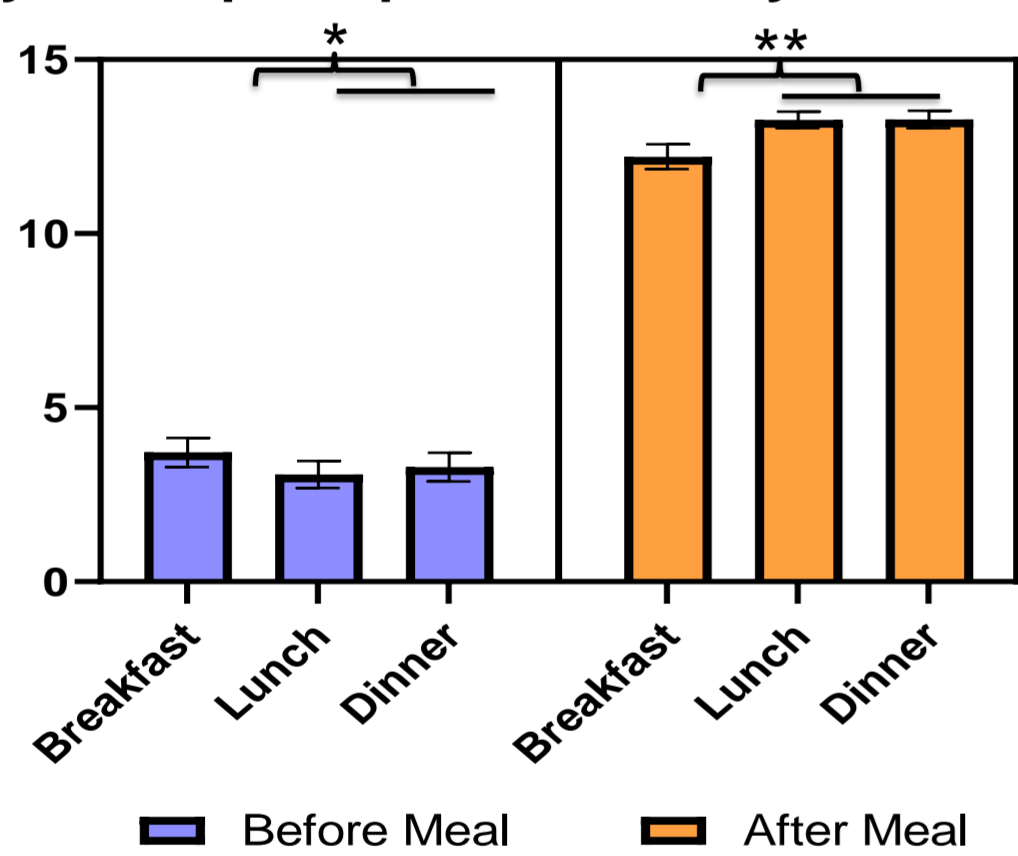
## RESULTS

### Results 1 : Daytime dynamics of hunger and satiety perception

#### Dynamic perception of hunger over the day



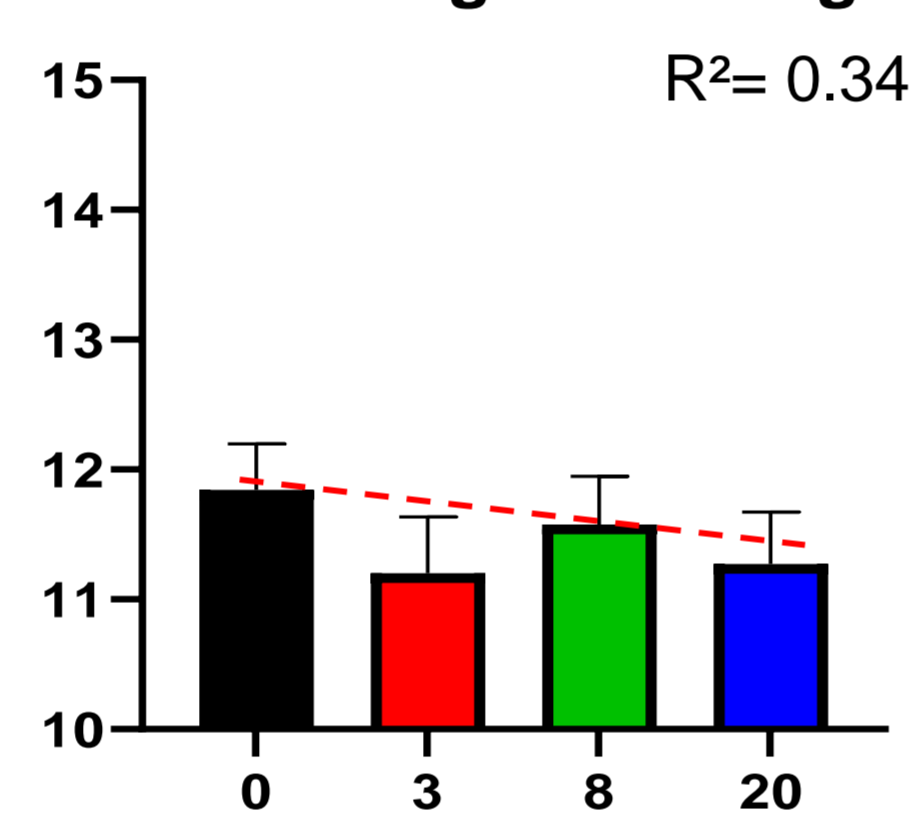
#### Dynamic perception of satiety over the day



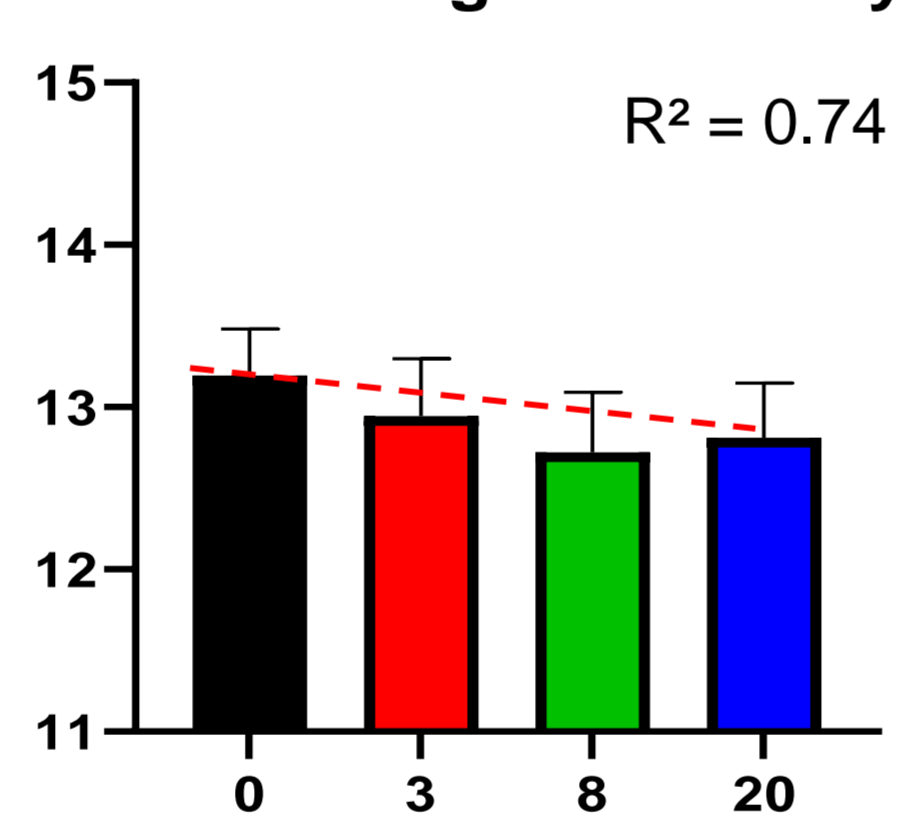
Both hunger and satiety have shown significant differences between breakfast and lunch/dinner. Perception of hunger and satiety varies significantly over the day ( $p < 0.01$ ).

### Results 2 : Effects of light at night on overall daytime hunger and satiety

#### Effect of light on hunger



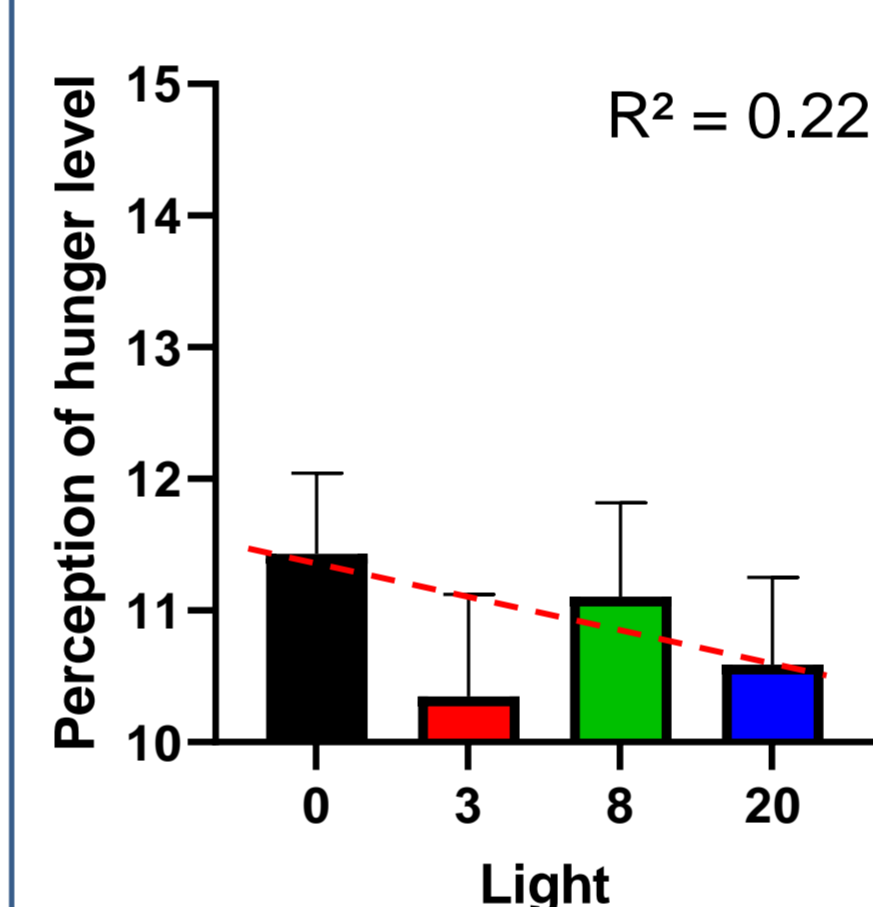
#### Effect of light on satiety



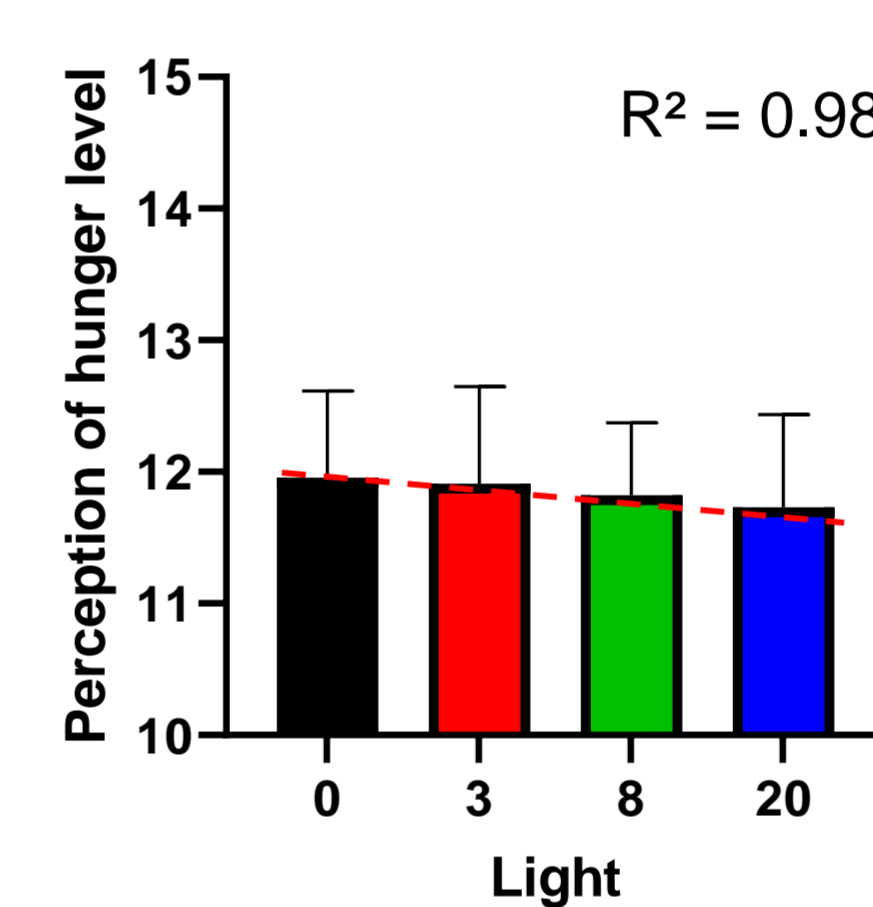
Above: Feeling of hunger before meal, (0: not at all hungry, 15: very hungry).  
Below: Feeling of satiety after meal, (0: not quite full, 15: very full).

### Results 3 : Effects of light at night on hunger and satiety before/ after each meal

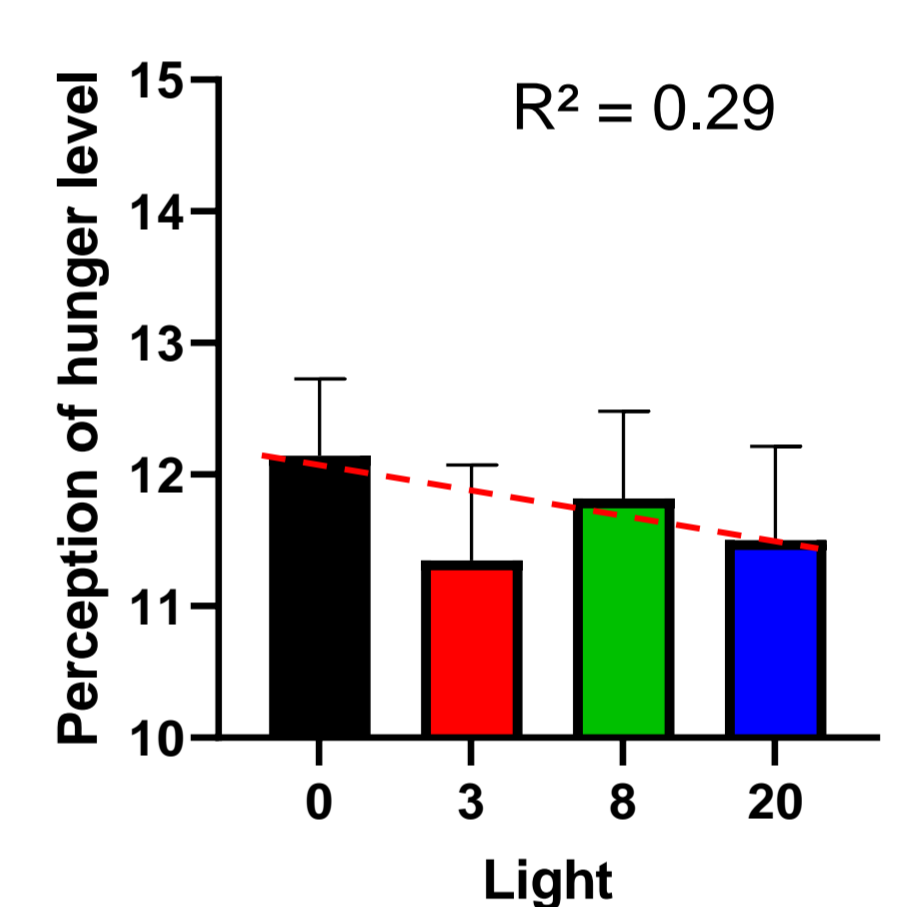
#### Before breakfast



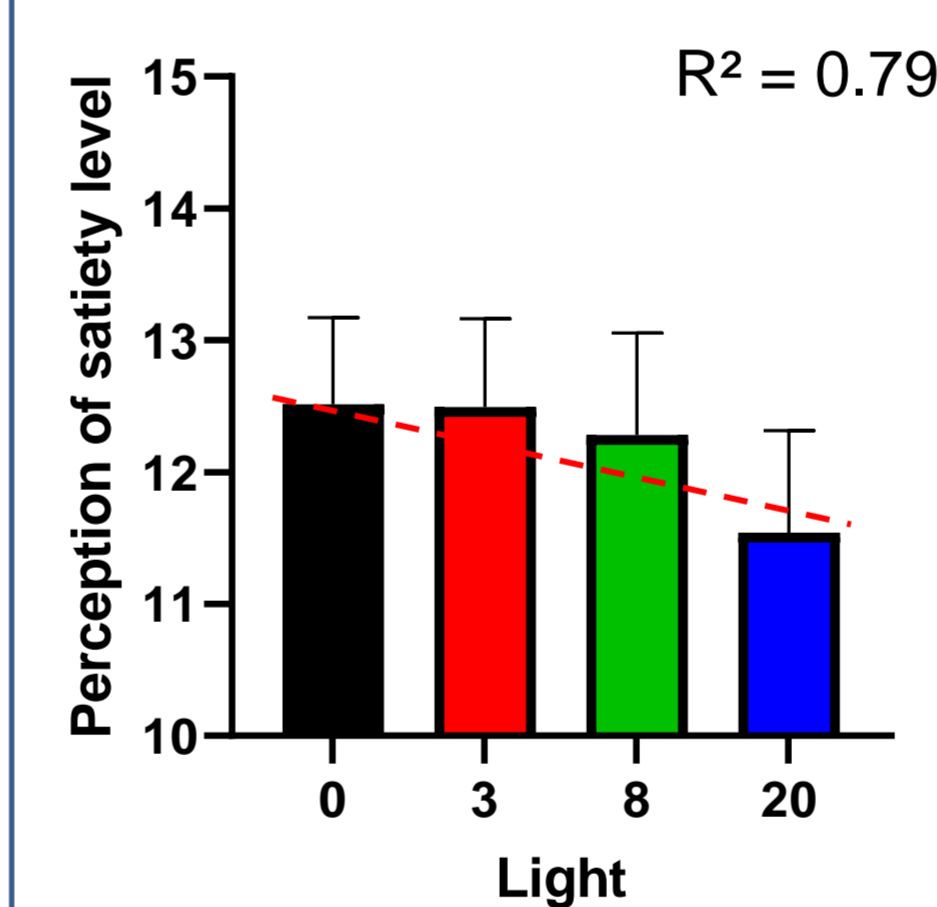
#### Before lunch



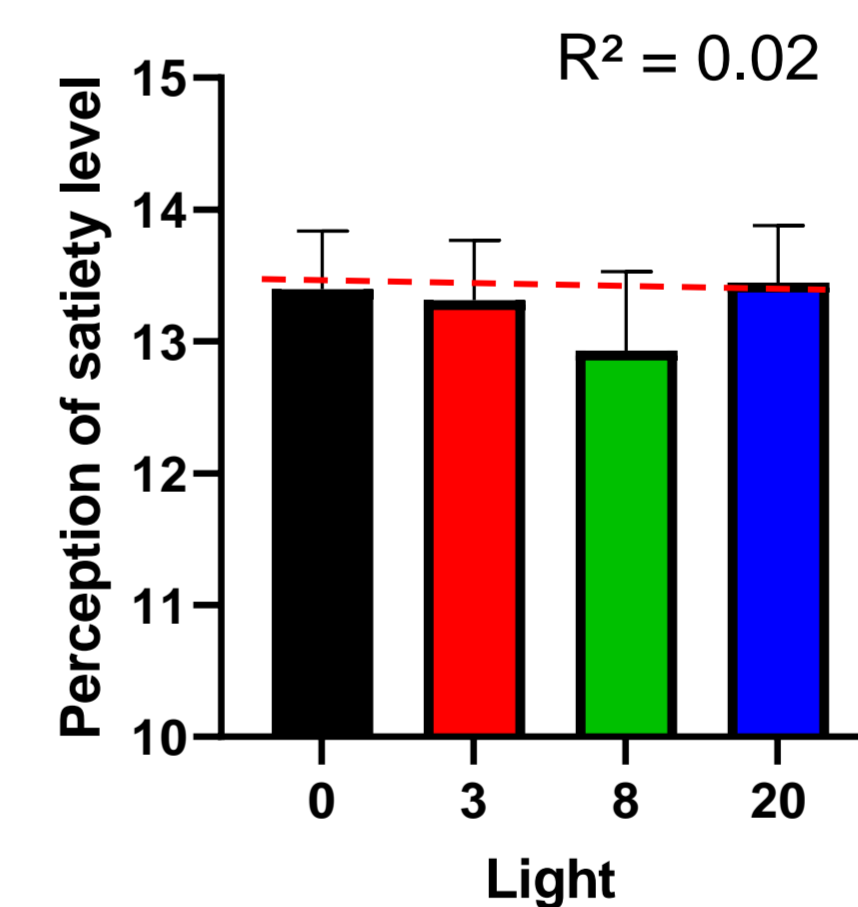
#### Before dinner



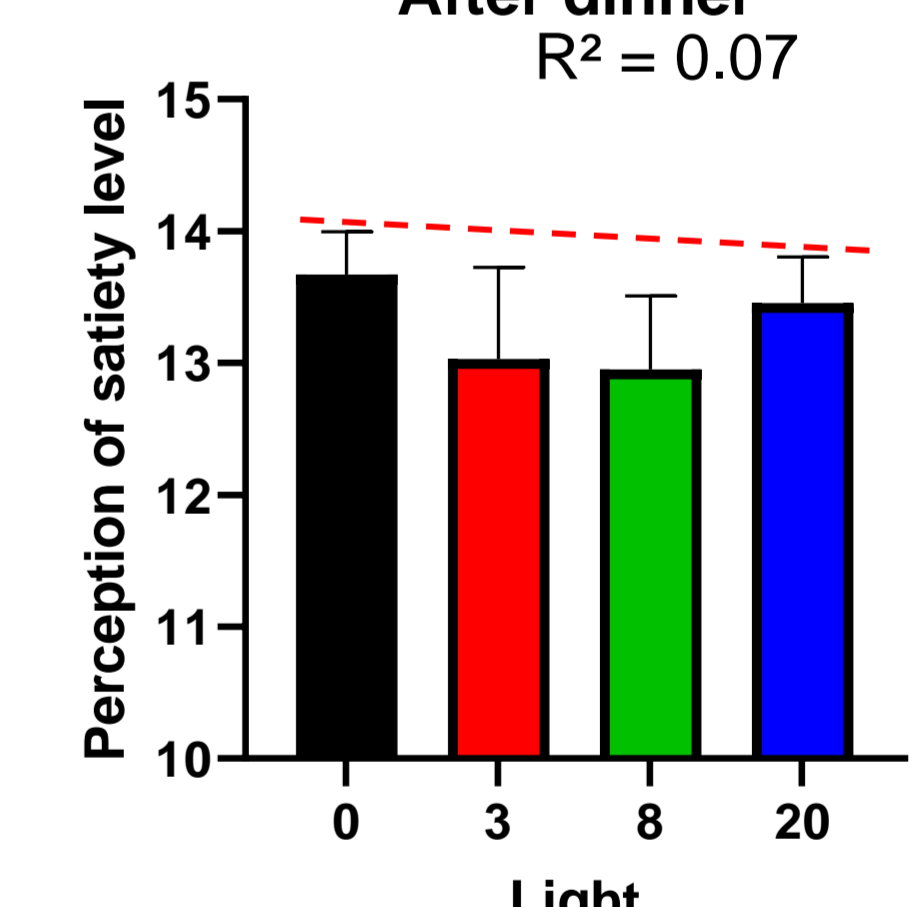
#### After breakfast



#### After lunch



#### After dinner



Interaction between meal and light: hunger (above) and satiety (below). Both time of day and artificial light at night affect subjects' perceptions of hunger and satiety throughout the day. Lme function for all analysis : (Hunger/ Satiety ~ Meal + Light + Day + Meal \* Light + Meal \* Day + Day \* Meal + Meal \* Light \* Day, random = 1| Subject)

## CONCLUSIONS

- Perception of hunger and satiety varies with time of day. The strongest interoception is found at lunch time.
  - A number of linear trends have been found linking interoception and nocturnal light intensity, with increasing artificial light at night tending linearly to decrease interoception responses.
  - The effect of light intensity on perception was not uniform throughout the day, with the best linear effects observed after breakfast and before lunch.
- Further analyses are in progress to clarify whether the effect of light on interoception and exteroception are related to changes in sleep architecture/quality or in circadian physiology (amplitude/phase).

## REFERENCES

[1] Spiegel, K., Leproult, R. & Van Cauter, E.. (1999). [2] Spiegel, K., Tasali, E., Penev, P. & Van Cauter, E.. Med. (2004). [3] Sørensen, L. B., Møller, P., Flint, A., Martens, M. & Raben, A.. Int. J. Obes. (2003). [4].Berthoud, H.-R., Morrison, C. D. & Münzberg, H. Physiol. Behav. (2020). [5] Prayag AS, Münch M, Aeschbach D, Chellappa SL & Gronfier C. Clocks & Sleep (2019).

## ACKNOWLEDGEMENTS

Funding : Grants from ANR (Idex Breakthrough ALAN) and UCBL (Rectolux) to CG, fellowship from a Chinese private company to XW.  
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