Characterisation of pupillary responses to alternating blue and orange light exposures in a fMRI protocol

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Introduction:

The non-image forming (NIF) functions of light are diverse and include stimulation of cognition and alertness, sleep regulation and pupil diameter modulation. Previous work indicated that exposure to blue-enriched light as well as pupil size variations are associated with higher locus coeruleus (LC) activity. Given the central role of LC structure and function in the earliest stages of Alzheimer's disease neuropathology, light exposure may constitute a promising stimulation technique to delay disease progression. Prior to addressing light impact on the LC, here, we aimed at characterising the pupil responses to light during fMRI protocol, to determine its quality in assessing NIF effects of light.

Methods:

Pupil diameter was continuously recorded in 11 healthy subjects (20-30yr, 7 women) with an infrared eyetracker device while they were administered a 15-min auditory oddball task in a 7T MRI scanner. Participants were concomitantly exposed to pseudo-randomly alternating 30s blocks of blue-enriched (4,000K; 200µW/cm^2) and orange (589nm; 6x10^{13}photons/cm^2/s) lights. Statistics consisted in generalized linear mixed models seeking effects of light condition on pupil response, with subjects as random intercept and controlling for age, sex and BMI.

Results:

Blue light condition was associated with a significantly smaller pupil diameter as compared to the orange condition, (main effect of light condition: $F(2,270)=571.22;p<.0001$). Moreover, the

impact of the light condition on pupil size did not significantly change over the 15min-protocol (light condition x block repetition interaction: $F(12,240)=1.21$; $p=.28$), suggesting that time-in-protocol and prior light blocks did not influence pupil constriction.

Conclusion:

We report preliminary results confirming that blue-enriched light triggers a stronger pupil response than longer wavelength light and showing that the protocol induces a stable response in time even when using short alternating light exposures. These findings support the validity of the protocol to assess NIF responses to light in fMRI in healthy participants, including over the LC. Being able to stimulate the LC holds important implications for possibly delaying Alzheimer's disease progression. We now aim to include more participants, including older individuals, and to extend to other cognitive tasks to assess the generalization of the present findings to other cognitive domains and age-ranges.

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