

Environmental Temporal Cognition Lab Report 2024/25

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Executive Summary

This report synthesises 2025 projects from the Environmental Temporal Cognition Lab on how light, scene context, and mood influence perceived time. We combined 360 degree VR experiments with a qualitative survey of people living at higher latitudes.

In the main VR study, students viewed six 120 second 360 degree clips filmed in the United Kingdom and northern Sweden at morning, afternoon, and evening.

Prospective duration estimates were longer for Sweden than United Kingdom scenes, with the largest site difference in the evening. Higher depression scores were associated with larger overestimation in lower light evening conditions.

Chronotype and seasonality showed no reliable moderating effects in this small sample.

A second VR project using 30–90 second winter scenes reported robust duration biases tied to interval length, but found no clear effects of chronotype, seasonal affectivity, time of day, or their interactions under those conditions. This provides an informative contrast and helps bound our claims.

The qualitative study analysed open-ended responses from 28 residents of Scandinavia and nearby regions. Four themes emerged: circadian changes with light exposure, mood fluctuations, time and chronotype, and adaptations and preferences. Participants frequently reported sleeping more in darker winter months and less in brighter summer months, and they described adjustments to routines as a coping

strategy. These accounts support links among light, sleep timing, mood, and the felt passage of time.

Taken together, the studies suggest that evening and lower light contexts can lengthen perceived duration in naturalistic scenes, with mood as a potential amplifier, while also showing conditions under which such effects may be weak or absent.

Limitations recur across projects, including small student samples, single-session designs, uncalibrated luminance, and natural content differences between sites and times of day. Planned work will increase sample size, calibrate light measurements, vary interval length, and collect repeated measures across seasons, with preregistration and open materials on OSF.

Key findings at a glance.

Eardley, Fawzan and Hearn VR study

Students viewed six 120 second 360° clips filmed in the UK and northern Sweden at morning, afternoon, and evening. After each clip they gave a prospective duration estimate and completed PHQ-9, SPAQ, and MCTQ. A main effect of site and a Site by Time-of-Day interaction emerged, with the largest difference in the evening. Higher PHQ-9 strengthened the site effect. Chronotype and seasonality were null. N = 12, within-subjects, single session.

Hercocock and Studley VR study

Participants viewed six 90 second 360° clips that varied by environment and time of day. Duration estimates were collected on a slider. The only reliable effect was an Environment by Time-of-Day interaction. No clear effects of chronotype were found. N = 18 valid datasets, within-subjects, single session.

Lupińska and Cridland VR study

Participants viewed winter-themed 360° clips of 30, 60, and 90 seconds at morning, midday, and evening. Duration bias increased with interval length. There were no significant effects of chronotype, SAD symptoms, time of day, or their interactions. N = 27, within-subjects, single session.

Harris qualitative survey at high latitudes

Open-ended online survey of adults living in Scandinavia and nearby regions.

Thematic analysis produced four themes: circadian changes with light exposure, mental health and mood fluctuations, time and chronotype, and adaptations and preferences. Many respondents reported longer sleep in darker months and earlier waking in brighter months. N = 28, thematic analysis.

Synthesis across projects

Across studies that used naturalistic 360° scenes, evening or lower-light contexts were associated with longer prospective duration estimates, although this pattern was small or absent in some designs with different intervals and stimuli.

Mood moderated context effects in the Eardley and Hearn study, where higher PHQ-9 amplified longer estimates for Sweden scenes, especially in the evening.

Chronotype and seasonality showed no consistent moderating effects in these small samples.

Qualitative data align with the experimental pattern by linking seasonal light to sleep timing and felt time, and by describing practical adaptations that may buffer these effects.

Methods Harmonisation

This report harmonizes all 2025 ETC projects that used prospective duration judgments in 360 degree scenes and one qualitative survey. The primary outcome is ratio estimate. Predictors are Site, Time of Day, and Environment Type where available. Moderators are PHQ-9, MCTQ, and SPAQ, z scored within study. We

exclude missing trials and participants with fewer than four valid trials. We fit linear mixed effects on ratio estimates with fixed effects for Site, Time of Day, and their interaction, plus PHQ-9 as a moderator, and random intercepts for participant and study. Secondary models analyse signed error for 120 second clips and add Environment Type. Assumptions are checked with Q–Q and variance tests, with robust models as sensitivity checks. A leave-one-study-out analysis tests stability. The qualitative study is integrated using a convergence matrix that links themes to quantitative contrasts. Figures include a forest plot of study effects, an interaction plot, and a moderation slope. Limitations include small samples and uncalibrated luminance.

General introduction

Human experience of time is elastic. People often report that minutes feel longer in dim, quiet settings and shorter during engaging activity. Laboratory research supports this, showing that attention, arousal, and sensory input systematically alter prospective time judgments, with anxiety and boredom lengthening perceived duration and focused engagement compressing it (Block, Hancock, & Zakay, 2010; Droit-Volet & Meck, 2007; Zakay & Block, 1997). Visual conditions matter too. Lower luminance produces “duration expansion,” in which identical physical intervals are judged longer than under brighter viewing (Bruno, Ayhan, & Johnston, 2011).

Light is also the primary cue that synchronises the human circadian system with the 24 hour day. Morning light advances circadian phase, evening light delays it, and even ordinary room light before bedtime can suppress and delay melatonin onset, pushing sleep later (Cajochen et al., 2005; Gooley et al., 2011; Khalsa, Jewett, Cajochen, & Czeisler, 2003). When time cues weaken or shift, circadian timing drifts. Classic time isolation studies in bunkers and caves show free running rhythms and frequent loss of day count when people live for weeks without clocks or natural light (Aschoff, 1965). In polar regions where sunrise and sunset can be absent for long periods, circadian and behavioral rhythms adapt but are stressed, and subjective time can feel altered, particularly during polar night (Arendt, 2012; Tortello et al., 2020).

History provides context for how nights feel. Before widespread artificial lighting, segmented sleep with a wakeful interval between a “first” and “second” sleep was common in many settings. That pattern suggests that a brief period of quiet wakefulness in the middle of the night can be a normal part of human sleep under long dark nights (Ekirch, 2001; Wehr, 1992). In contrast, work on contemporary communities without electricity shows mostly consolidated nocturnal sleep, highlighting the flexibility of human sleep across environments (Yetish et al., 2015). Taken together, these findings motivate questions about how light, environment, and mood shape perceived time in everyday contexts, especially in the evening when light is lower and stimulation often reduced.

This report synthesises 2025 projects from the Environmental Temporal Cognition Lab that examine perceived duration in naturalistic 360 degree scenes. The studies test whether context and time of day shift prospective time estimates and whether individual differences in mood, chronotype, and seasonality moderate these effects. The approach uses immersive videos to preserve ecological detail while controlling interval length. Across the projects we evaluate converging patterns, quantify limitations, and outline a plan for larger, calibrated replications.

Project Overviews

Evening context and mood lengthen perceived duration in 360° VR (Eardley, Fawzan and Hearn, 2025)

Twelve students viewed six 120 second 360° clips recorded in an urban UK site and a rural site in northern Sweden at morning, afternoon, and evening. After each clip, participants estimated duration on a 0 to 300 second scale and completed PHQ-9, SPAQ, and MCTQ questionnaires. A linear mixed model showed a main effect of site, with longer estimates for Sweden scenes, $F(1,60) = 6.49$, $p = .013$. There was a Site by Time-of-Day interaction, $F(2,60) = 4.58$, $p = .014$, driven by a large evening gap. Evening Sweden was judged about 35 seconds longer than evening UK after Bonferroni correction, 95% CI -57.9 to -12.0 , $p = .005$. Depression moderated the context effect, $F(2,60) = 3.48$, $p = .037$. Fixed-effects estimates indicated about a 5.6 second increase in judged duration per SD of depression for Sweden relative to UK. Assumption checks were satisfactory. The data support an attention-based account in which lower luminance and less stimulation in evening scenes increase attention to time, with elevated depressive symptoms amplifying this effect. Limitations include a small sample, single session, uncontrolled luminance, and natural content differences between sites.

Environment and time of day shift duration estimates in 360° VR (Herccock & Studley, 2025)

Eighteen students viewed six 90 second 360° clips that crossed environment and time of day. Urban UK morning, noon, and afternoon were contrasted with rural Sweden morning, noon, and afternoon. Participants estimated duration after each clip and completed the Morningness-Eveningness Questionnaire. A mixed model found no main effects of environment, time of day, or chronotype, but a significant Environment by Time-of-Day interaction, $F(2,90) = 3.37$, $p = .039$. Rural estimates were lowest in the morning and higher at noon and afternoon. Urban estimates were highest in the morning and dropped at noon, then rose slightly in the afternoon. Bonferroni pairwise comparisons did not survive correction, so the interaction should be interpreted cautiously. Assumptions of normality and equal variance were met. The method masked the time-estimation aim and used randomised clip order. The study supports context-dependent timing with modest effects that may vary by scene content and light level. Lack of calibrated luminance and a student sample limit generality.

Interval length and winter scenes bias prospective timing in 360° VR (Lupińska and Cridland, 2025)

Twenty-seven students completed nine VR trials depicting a snowy landscape at morning, midday, and evening with durations of 30, 60, or 90 seconds. After each trial, participants reported the perceived duration on a continuous scale and completed rMEQ and a modified SPAQ. The primary result was a robust main effect of duration on signed estimation error, $F(1.75,45.53) = 61.85$, $p < .001$.

Underestimation increased with interval length, consistent with scalar timing and

Bayesian central-tendency accounts. No significant effects were found for time of day, chronotype, seasonality, or their interactions. Post hoc power indicated excellent sensitivity for the duration effect but low power for time-of-day contrasts. The VR setup provided ecological scenes, but headset luminance and scene luminance were not calibrated. Individual differences were substantial, with analyses attributing a large share of variance to participant-level factors. The study validates immersive VR for timing research and narrows the likely size of light and chronotype effects at these intervals.

High-latitude living: sleep, mood, and felt time from resident reports (Harris, 2025)

Twenty-eight adults living mainly in Scandinavia completed an open-ended online survey about light, sleep, mood, and the felt passage of time across seasons.

Reflexive thematic analysis yielded four themes. First, circadian change with light exposure. Respondents commonly reported more sleep in darker months and earlier waking with brighter summer light. Second, mood fluctuation with season, including lower energy and reduced motivation during polar night and improved mood with extended daylight. Third, time and chronotype. Several participants described slower felt time during long dark evenings and faster days in bright summer, with perceived effects varying by morningness or eveningness. Fourth, adaptations and preferences. Residents reported using routine, social timing, and targeted light exposure to stabilise sleep and mood. The study adds qualitative evidence that

seasonal light shapes sleep timing, mood, and subjective time, complementing the VR findings and pointing to cultural and routine factors that aid adaptation.

Cross-study synthesis

Across the projects, two patterns recur. First, scenes filmed in the evening or carrying lower-light cues tend to produce longer prospective duration estimates. This effect is clearest in the Eardley, Fawzan and Hearn study with 120 second clips, where a site difference was largest in the evening. Second, higher depression scores are associated with larger overestimation under evening or lower-light conditions. Chronotype and seasonality do not show consistent moderation in these samples.

The effect is small or absent in designs that used different intervals and stimuli. Studies with 30 to 90 second clips show strong duration-length effects, with little evidence for time of day, chronotype or seasonality. This suggests that context effects are sensitive to interval length, scene content and analysis choices. Luminance was not calibrated in any project, so light operates as a cue rather than a measured dose.

Qualitative reports from high-latitude residents are consistent with this pattern. Respondents describe slower felt time during long dark evenings, faster days in bright summer, and the usefulness of routine and targeted morning light. These accounts align with the experimental results and point to cultural and behavioural adaptations that can buffer weak light cues.

Taken together, the studies support an attention-based account. Lower light and lower stimulation increase attention to time. Minutes then seem longer. The strongest experimental evidence appears at 120 seconds with evening scenes. Effects weaken when intervals are shorter or when scene differences are smaller. This motivates larger studies with calibrated photometry, varied durations and repeated sessions across seasons.

Planned replication and extensions

We will preregister hypotheses, exclusion rules, and models. We will increase power with a larger and more diverse sample. We will repeat sessions across seasons. We will calibrate luminance and spectrum using a photometer and spectrometer. Scenes will be matched by content and motion where feasible. We will include a wider set of durations. For example, 30, 60, 120, and 180 seconds. We will collect continuous engagement ratings to quantify stimulation. We will add morning outdoor light exposure as a measured covariate. We will include sleep timing from a one-week diary and actigraphy for a subset. Analyses will use linear mixed effects with random intercepts for participant and study and, where justified, random slopes. We will run leave-one-study-out and robust models as sensitivity checks. All code and de-identified data will be shared on OSF.

Practical implications

Morning light stabilises timing. Go outside within an hour of waking. Aim for 20 to 30 minutes in daylight. Keep evening light low. Reduce bright screens in the last hour before bed. Plan a modestly engaging evening activity. If you wake for a period at night, leave bed after about 20 minutes. Read a few pages in dim light. Return to bed when sleepy. For teaching and workplaces, schedule early meetings to allow brief daylight exposure first. Provide bright communal areas in the morning.

Ethics

All studies received approval from the Keele Psychology Student Project Ethics Committee. Participants provided informed consent and could withdraw using an anonymous code. The qualitative study used an online consent form and removed identifying details in transcripts.

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