Nexus Between Sustainable Buildings and Human Health: a Neuroscience Appraoch
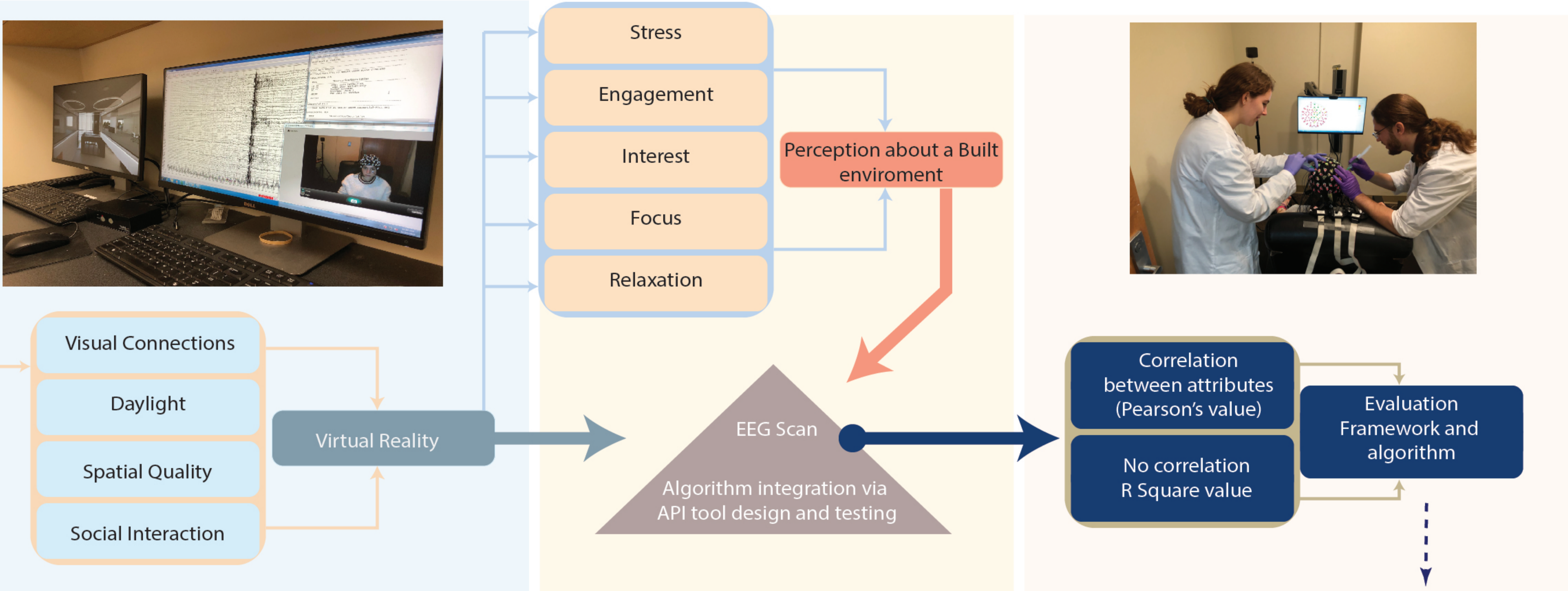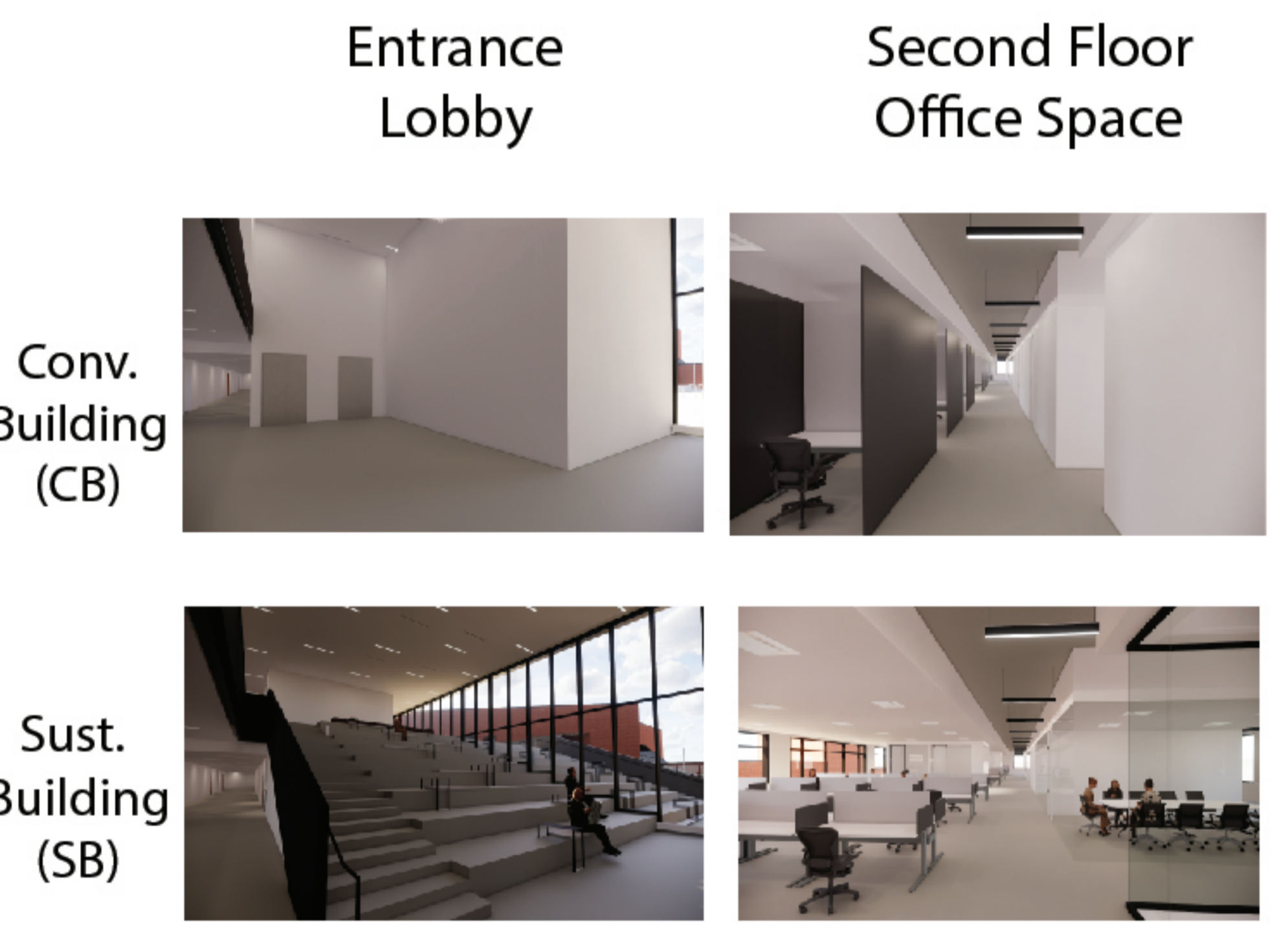
Principal Investigators: Edward Bernat, Madlen Simon, and Ming Hu
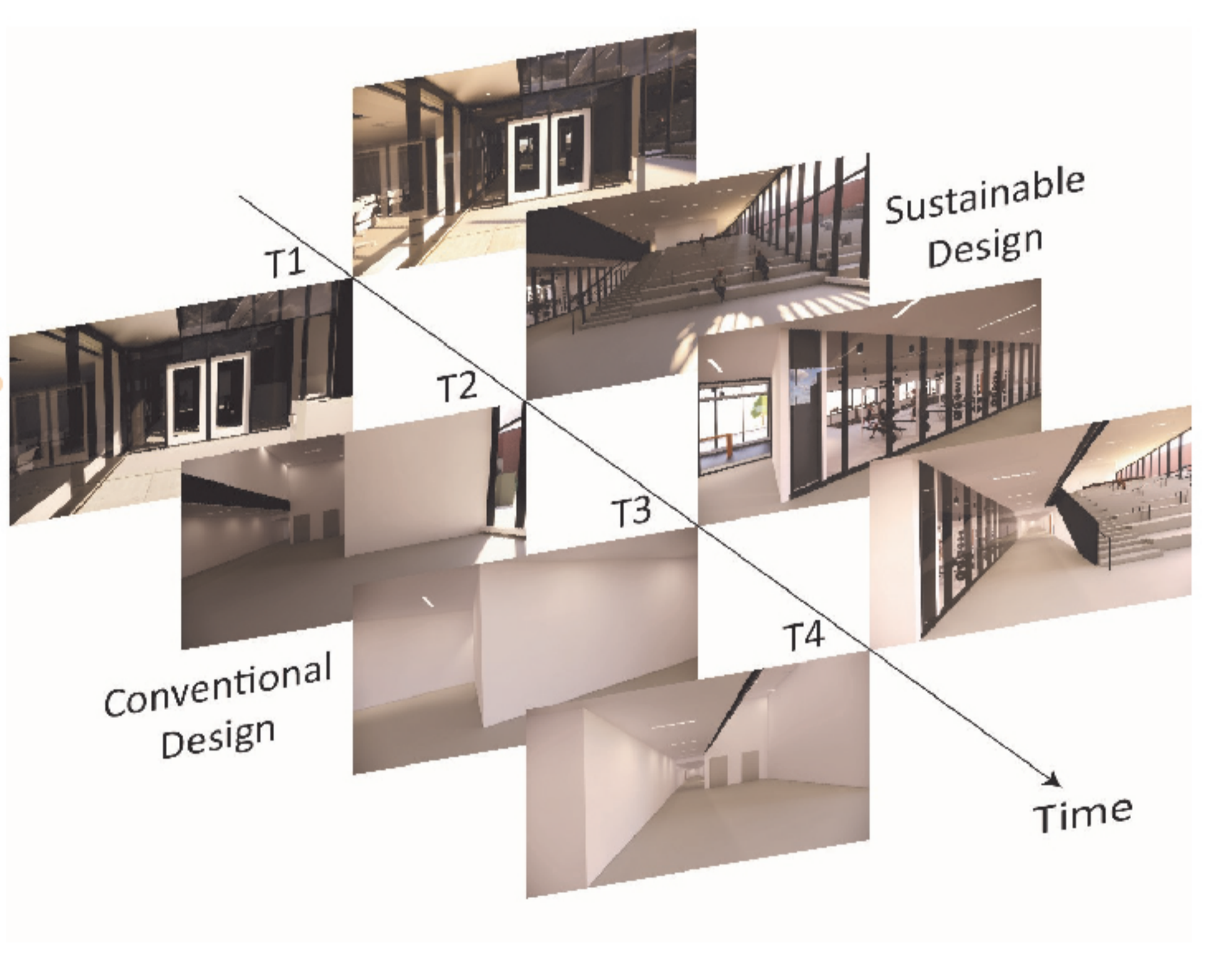
Stress

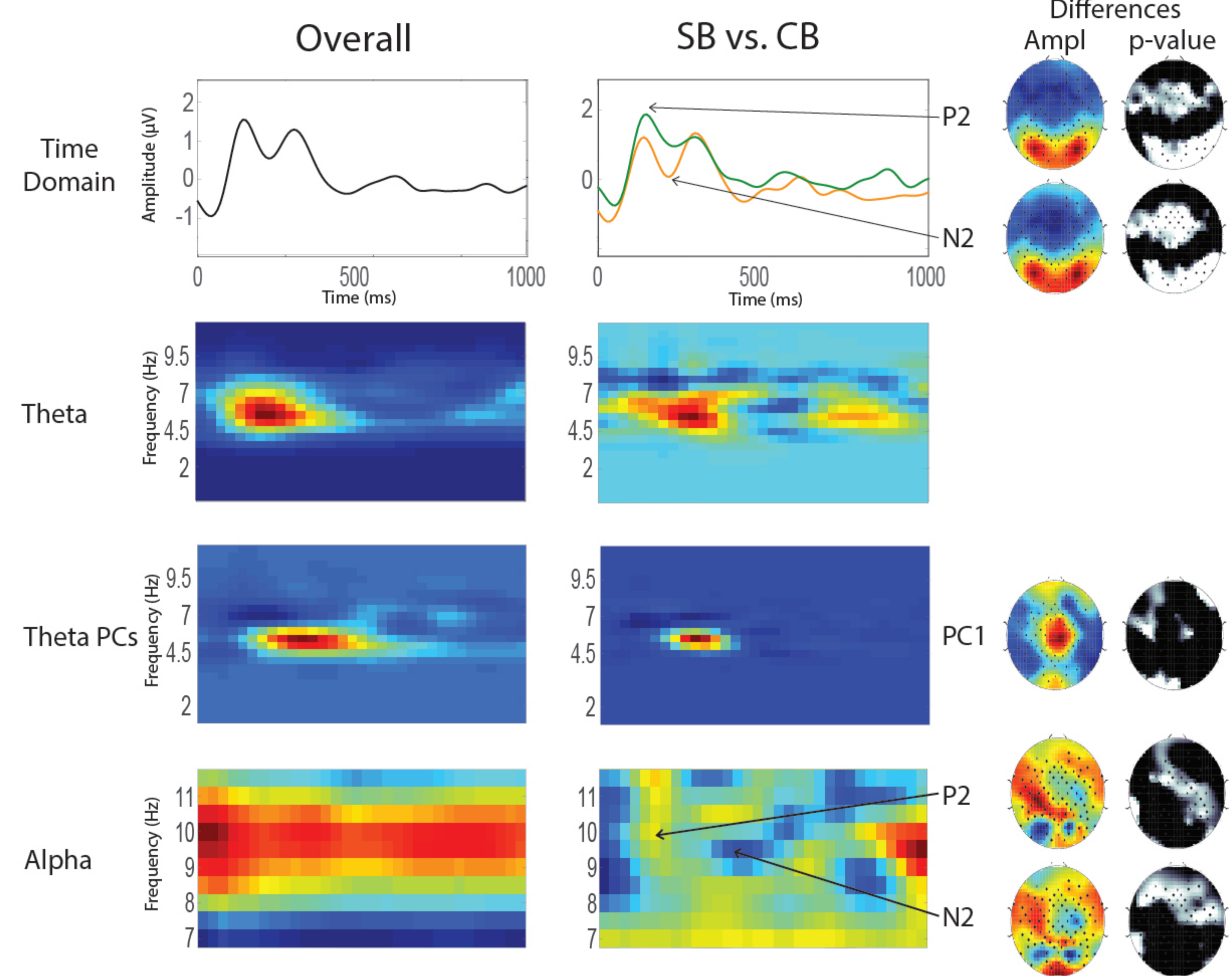Engagement

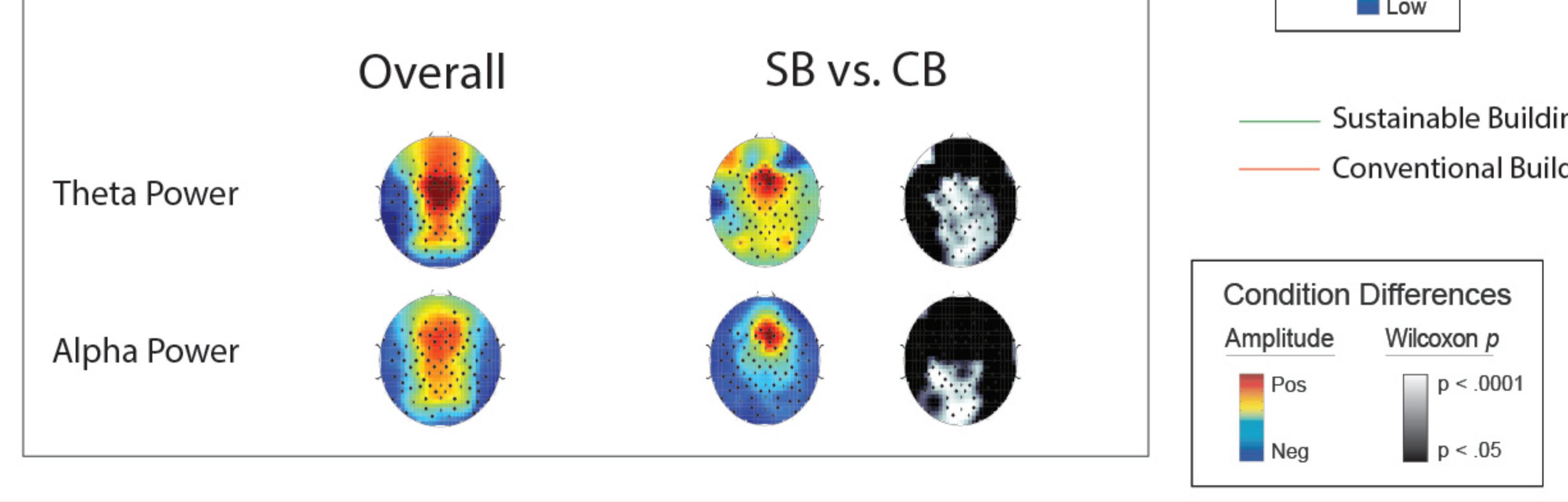Interest

Focus

Relaxation

Perception about a Built enviroment

Visual Connections

Daylight

Spatial Quality

Social Interaction

Virtual Reality

EEG Scan

Algorithm integration via API tool design and testing

Correlation between attributes (Pearson's value)

No correlation R Square value

Evaluation Framework and algorithm

VR Models

Example Stimuli

Entrance Lobby

Second Floor Office Space

Conv. Building (CB)

Sust. Building (SB)

Picture Viewing Task

T1

T2

T3

T4

Sustainable Design

Conventional Design

Time

Picture Viewing ERPs

Overall

SB vs. CB

Differences
Ampl   p-value

Time Domain

Amplitude (µV)

Time (ms)

P2

N2

Theta

Frequency (Hz)

Theta PCs

Frequency (Hz)

PC1

Alpha

Frequency (Hz)

P2

N2

PC Loadings
High
Low

Sustainable Building
Conventional Building

Movie Viewing EEG

Overall

SB vs. CB

Theta Power

Alpha Power

Condition Differences
Amplitude   Wilcoxon p
Pos   p < .0001
Neg   p < .05

Introduction: The goal of this research project is to develop, test, and validate a data-driven approach using virtual reality (VR) and electroencephalogram (EEG) technology for assessing the effect of architectural building design features on occupants' emotional and cognitive functions - proxies for mental health and wellbeing. The project will provide technology-enabled, repeatable measures for quantifying the "soft" benefits of building design features thus providing an economically viable and repeatable assessment model, pre-build.

Hypothesis: SBs, relative to CBs, produce positive mental health outcomes as measured by:
a. Increased engagement, involving orienting, attention, and arousal.
b. Increased focus, involving increased executive function.
c. Increases in interest, involving increased positive approach engagement.

Preliminary Conclusion:
- Picture Viewing -- Relative to CB, SB associated with:
    - Increased occipiatal activity
    - Reduced medial-frontal activity
    - Modulated alpha activity
- Movie Viewing -- Relative to CB, SB showed increased engagement:
    - Greater medial frontal theta
    - Reduced parietal alpha

Next Steps:
- Virtual Reality with EEG -- SB vs. CB

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