Salutogenic Workplace Design

Effects of Direct and Indirect Biophilic Interventions on Stress and Cognitive Function in Office Environments.

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Merle Zadeh is an architect from Berlin, Germany, with an additional Master in Neuroscience Applied to Architectural Design from IUAV University of Venice, Italy. With her firm, studio zadeh, she specializes in salutogenic architecture, exploring how design influences stress and health. Her work has been presented at the 15th and 19th Venice Architecture Biennale.



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Director of the Architectural Design Programme at Universidad Católica del Uruguay, UCU, and co-founder of Guevara Ottonello Architects, she combines professional practice and research to explore how architectural design can actively enhance health and well-being. Through projects, lectures, and studies in NeuroArchitecture, she promotes a human-centered approach that bridges scientific insight and creative design to shape healthier environments and communities

Research based assumption

Architectural Design



Wellbeing & Health

Research objective

To study the impact of architectural design on wellbeing and health our study focuses on measuring the following three dimensions in a virual office environment:

Emotional Response

Understanding how each spatial condition influences emotional valence, activation level, and preference.



Cognitive Performance

Identify possible variations in attention, inhibitory control, and working memory.



Stress Regulation

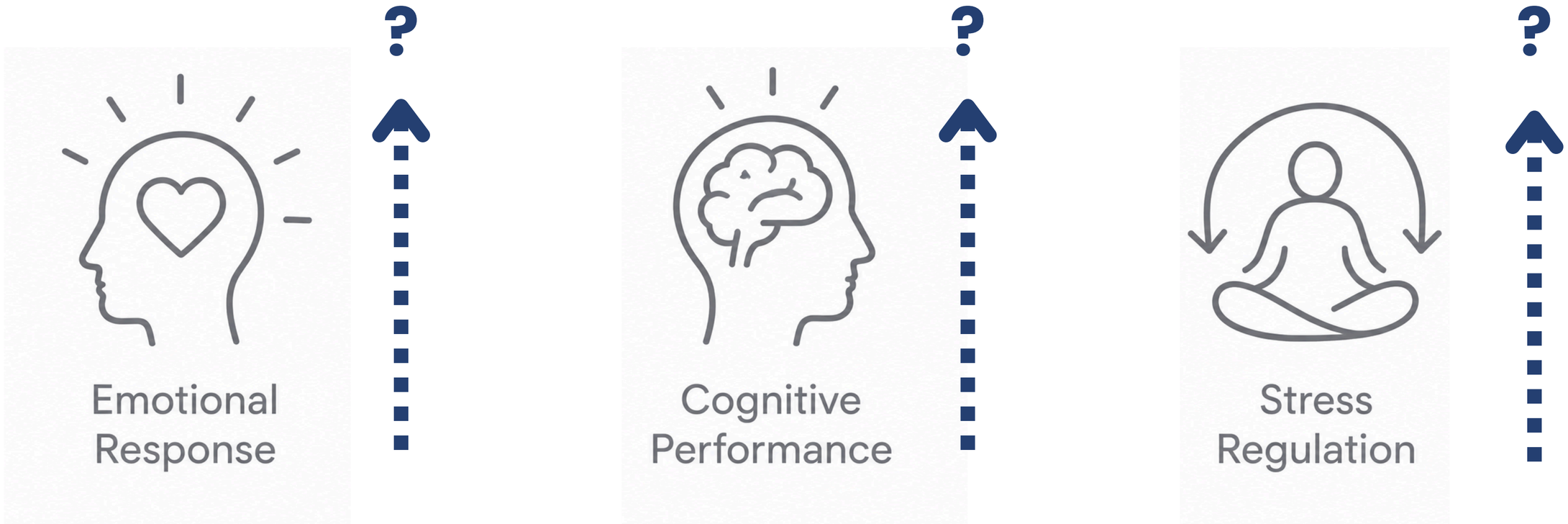
Quantify the changes in physiological response during exposure to each space and in subsequent recovery.



Research hypothesis

Based on the existing body of research we hypothesized that biophilic environments would perform better than a stripped down, basic control space.

Biophilic Workplace Design



Research Methodology: A Multimodal Within-Subject VR Experiment

Participants experienced three versions of the same virtual office. Spatial configuration, layout and lighting remained constant; the environmental design changed across conditions.



V1. Basic Control space

Neutral environment



V2. Indirect Biophilia

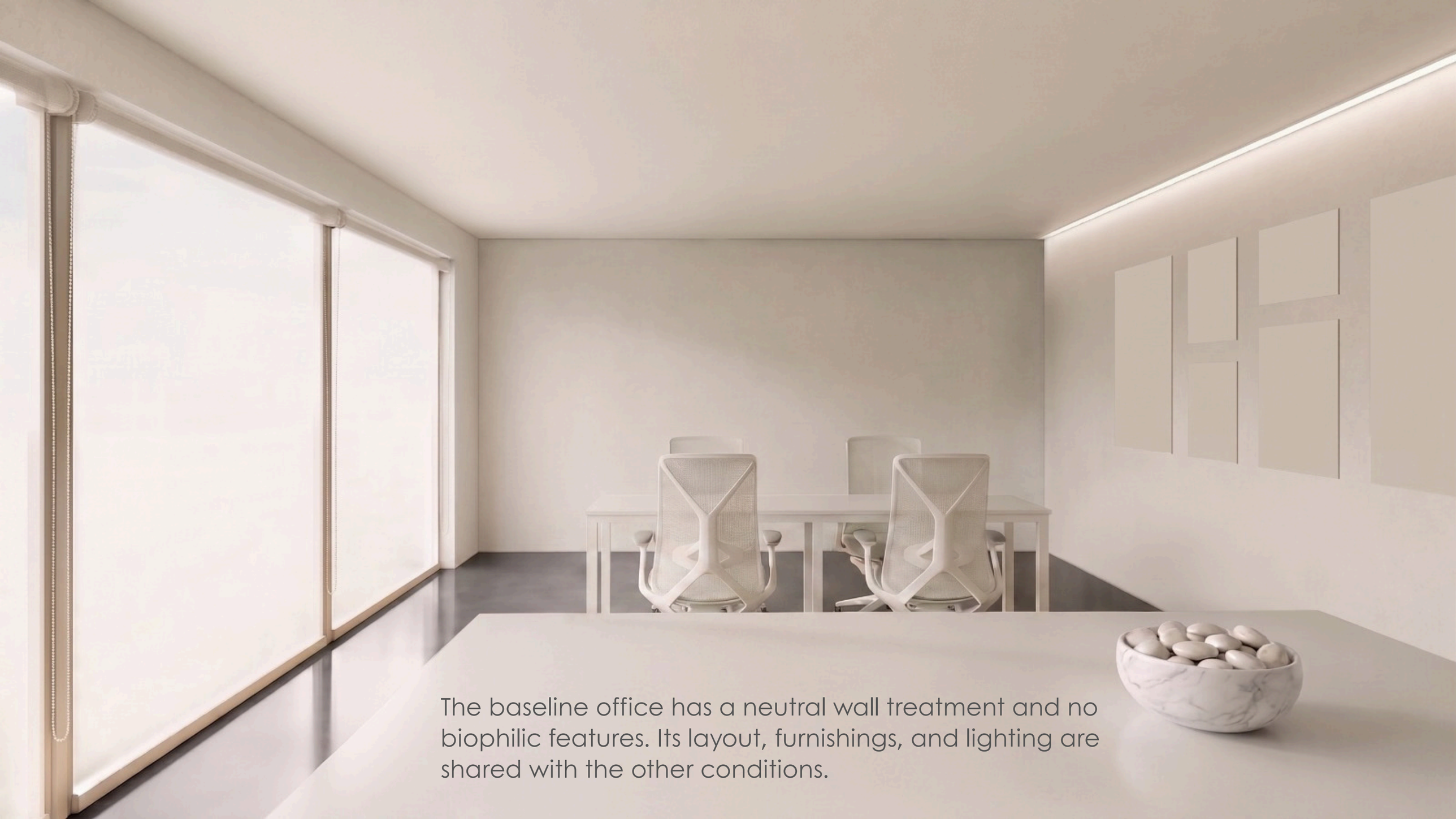
Natural materials



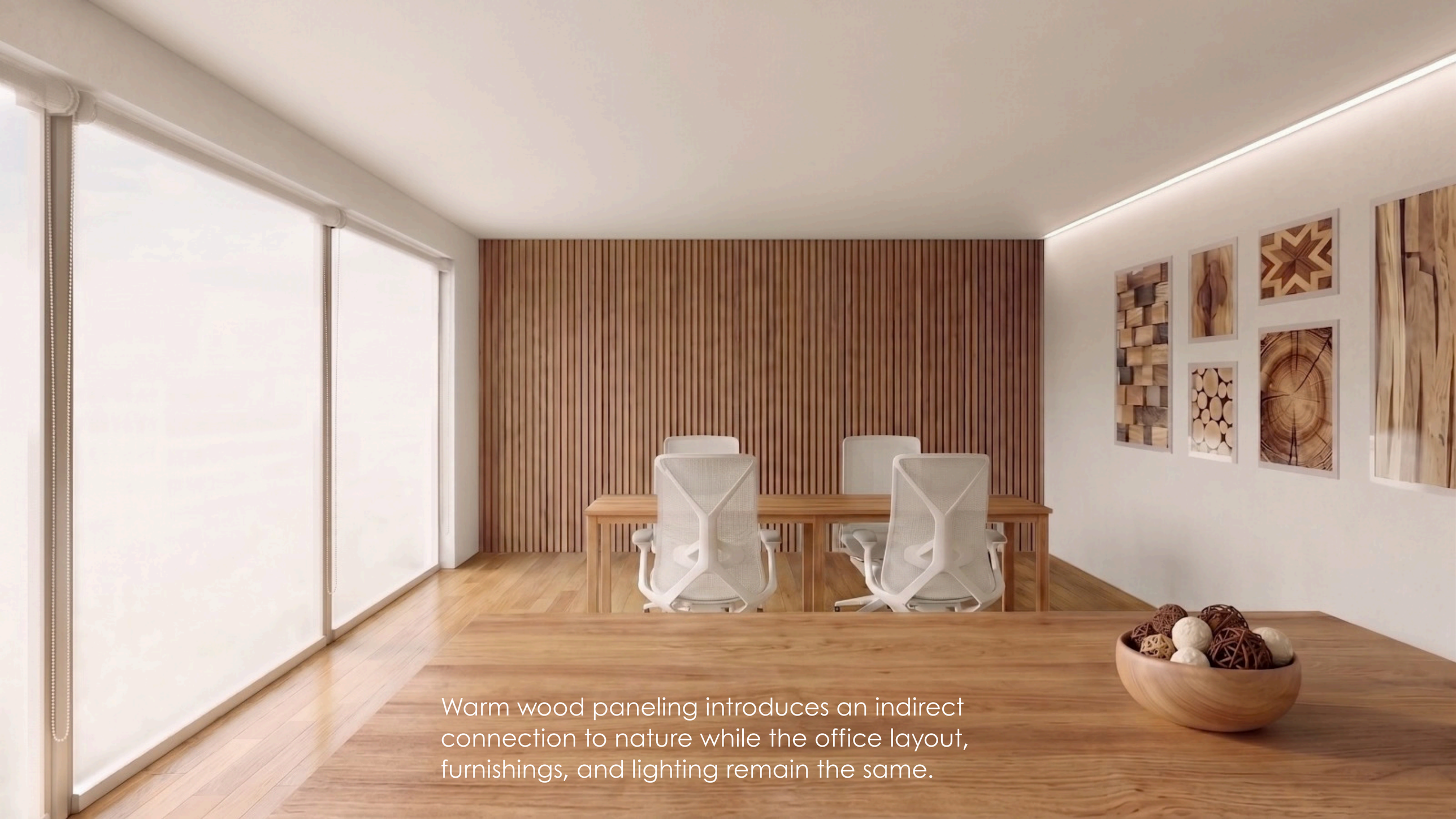
V3. Direct Biophilia

Living vegetation

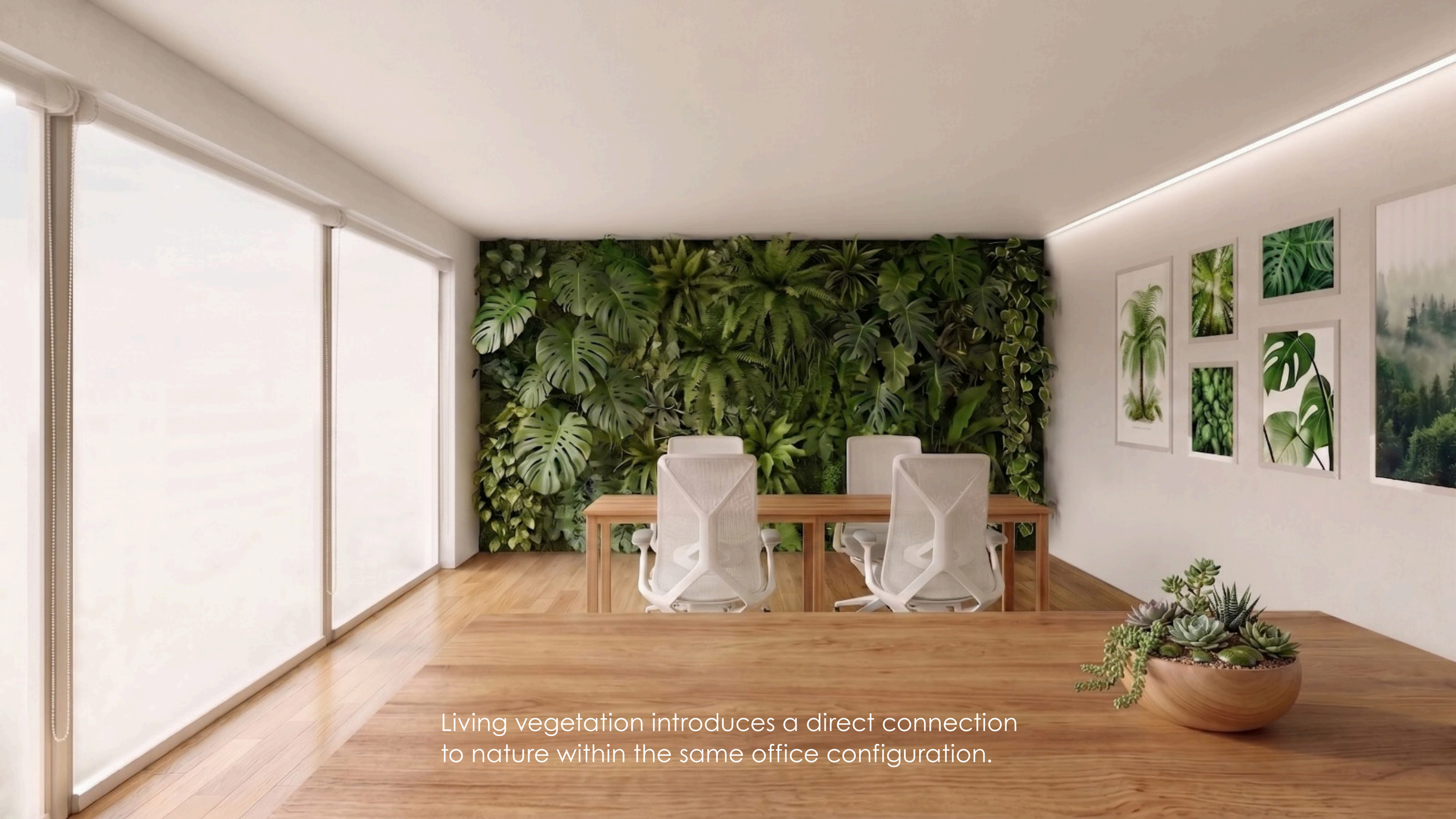
Comparing each biophilic office with the control condition allows us to examine the effects of introducing biophilic elements. Comparing indirect and direct biophilia allows us to explore whether the type of intervention (natural materials or living vegetation) makes a difference.



The baseline office has a neutral wall treatment and no biophilic features. Its layout, furnishings, and lighting are shared with the other conditions.



Warm wood paneling introduces an indirect connection to nature while the office layout, furnishings, and lighting remain the same.


Living vegetation introduces a direct connection
to nature within the same office configuration.

Research Methodology: Multimodal experimental study in virtual reality

Randomized, counterbalanced within-subject design.

Each participant experienced the three virtual office conditions and completed the same tasks in each environment. Emotional, cognitive, and physiological measures captured different aspects of their response to the spaces.

Emotional Assessment

Valence and Arousal Circumplex Model of Affect

In each condition, emotional valence and arousal level were assessed using scales based on the Circumplex Model of Affect. This allowed us to identify how each spatial configuration modifies the participants' emotional experience.

Cognitive Assessment

Flanker Test
2-back Test

Cognitive performance was analyzed using the Flanker Test, which assesses selective attention and inhibitory control, and the 2-back Test, which evaluates working memory. Accuracy and response times were recorded.

Physiological Evaluation

HR · HRV · Skin Conductance

The stress response and regulation were studied by continuously recording heart rate (HR), heart rate variability (HRV), and skin conductance (SCL/EDA) with Shimmer sensors, during exposure to each space and the recovery phases.

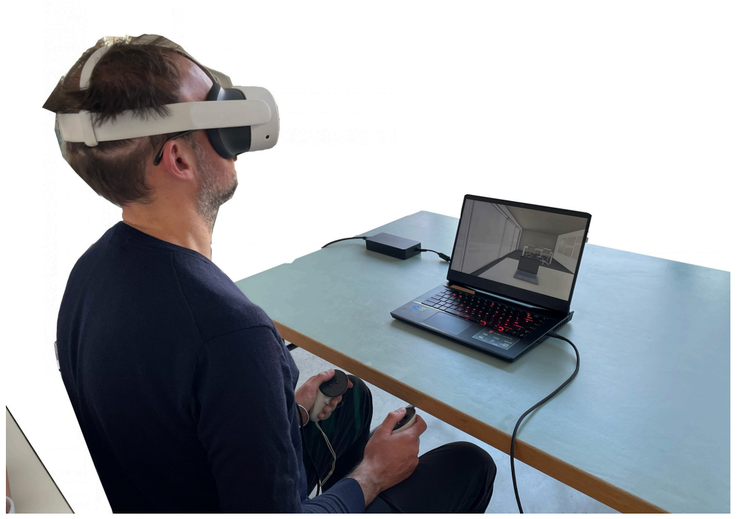
Working Inside a Virtual Office

Participants entered each office through a VR headset. Once immersed in the space, they completed computer-based tasks at a workstation, as they would during a working day. The same tasks were performed in all three office conditions.













Emotional Evaluation

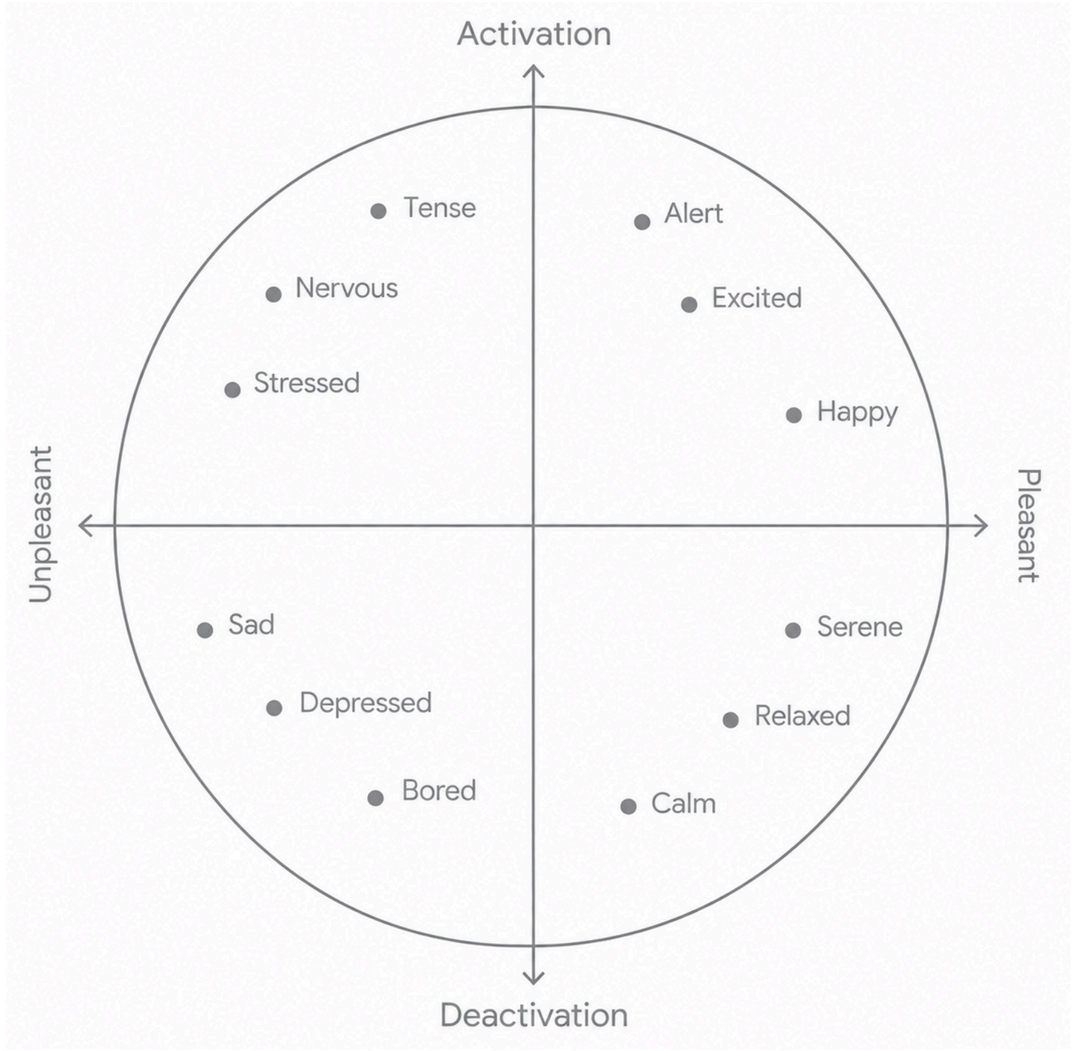
To evaluate the emotional impact of the rooms, two questions were asked, based on the two dimensions of the Circumplex Model of Affect

Valence: Unpleasant ↔ Pleasant



Arousal: Deactivating ↔ Activating



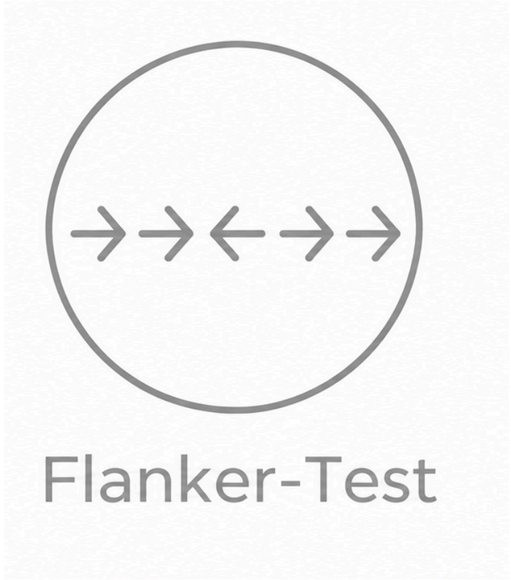


Circumplex Model of Affect (Russell)

Cognitive Evaluation

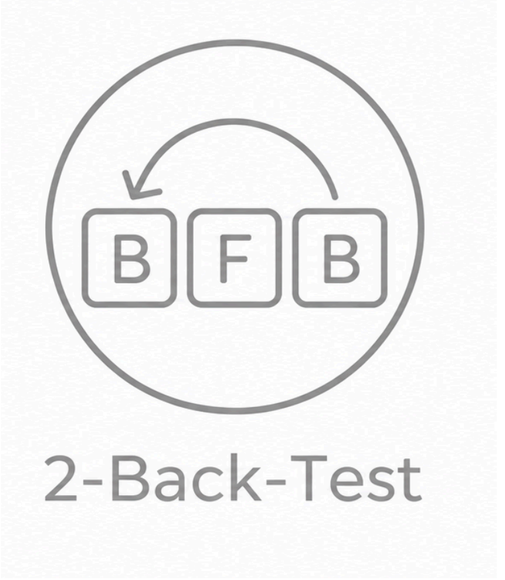






Selective attention

Participants respond to the direction of the central arrow while ignoring the surrounding arrows, allowing us to assess attention and response speed.



Working memory

Participants indicated whether each letter matched the one presented two steps earlier, allowing us to assess how accurately they maintained and updated information.

Physiological Evaluation

Measurement of Stress Response Biomarkers



Skin Conductance

Heart Rate

Heart Rate Variability

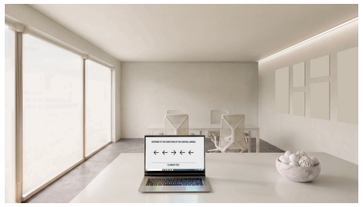


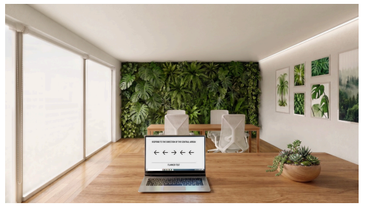
Counterbalancing the order of the workspaces

Latin Square Design

All six possible combinations of the three workspaces were used. This allowed each workspace to appear in the first, second, and third position, reducing the chance that the results were influenced by practice, fatigue, or the order in which participants experienced the spaces.

C1





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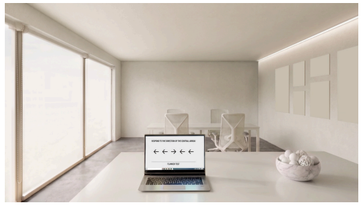
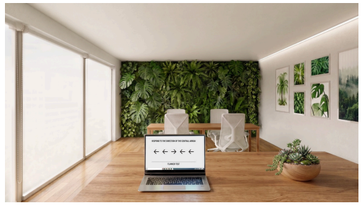
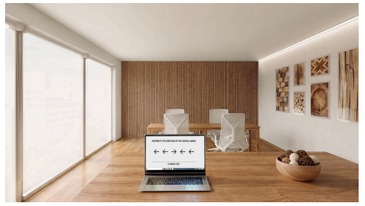

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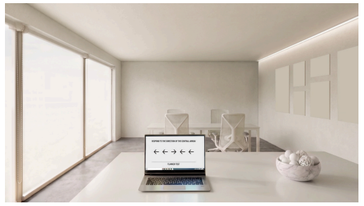
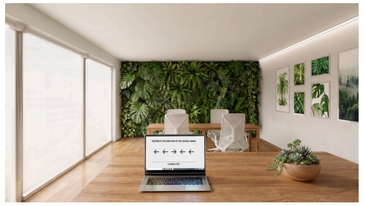

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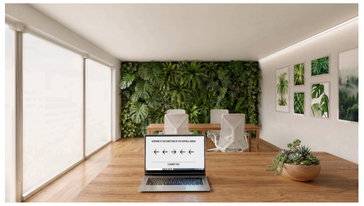
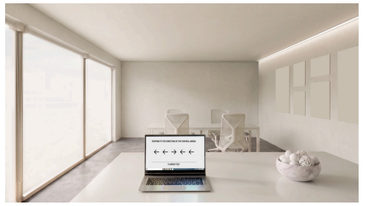

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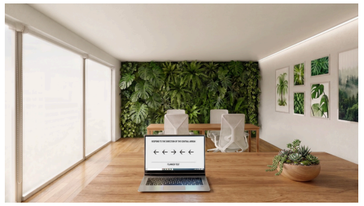
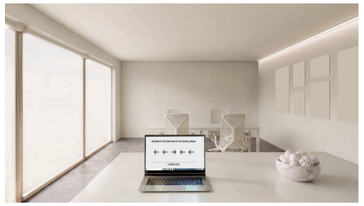


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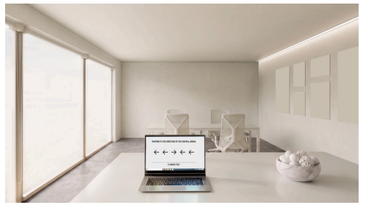
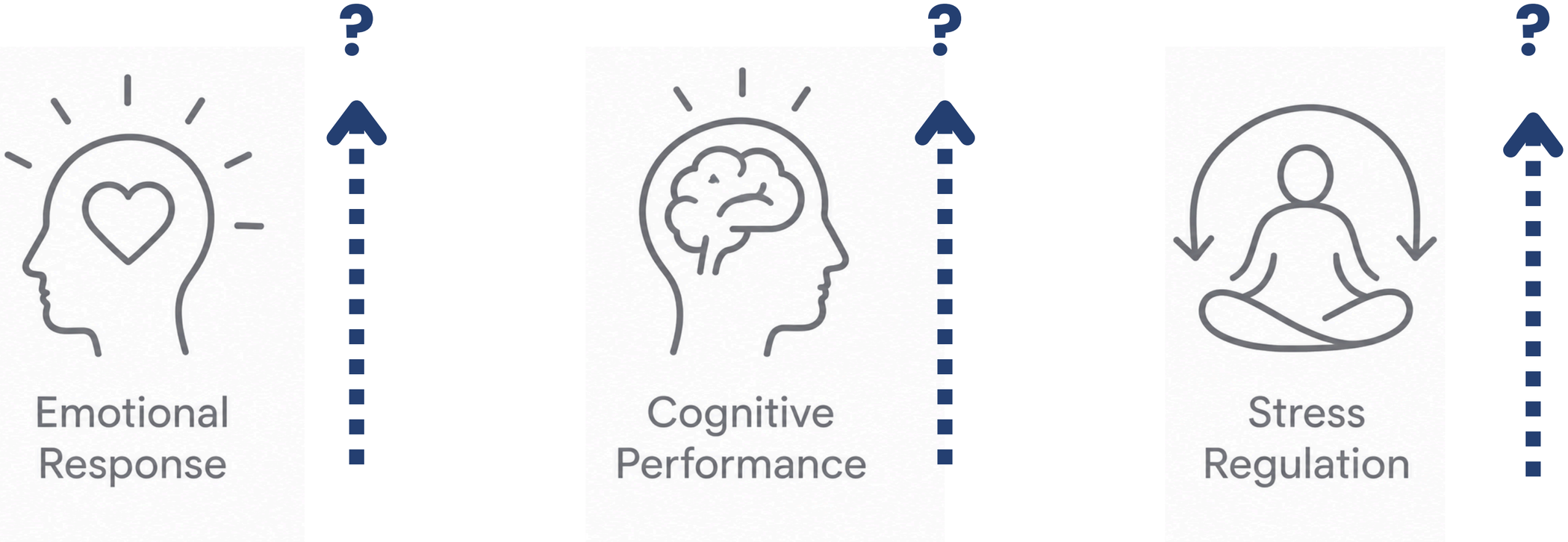
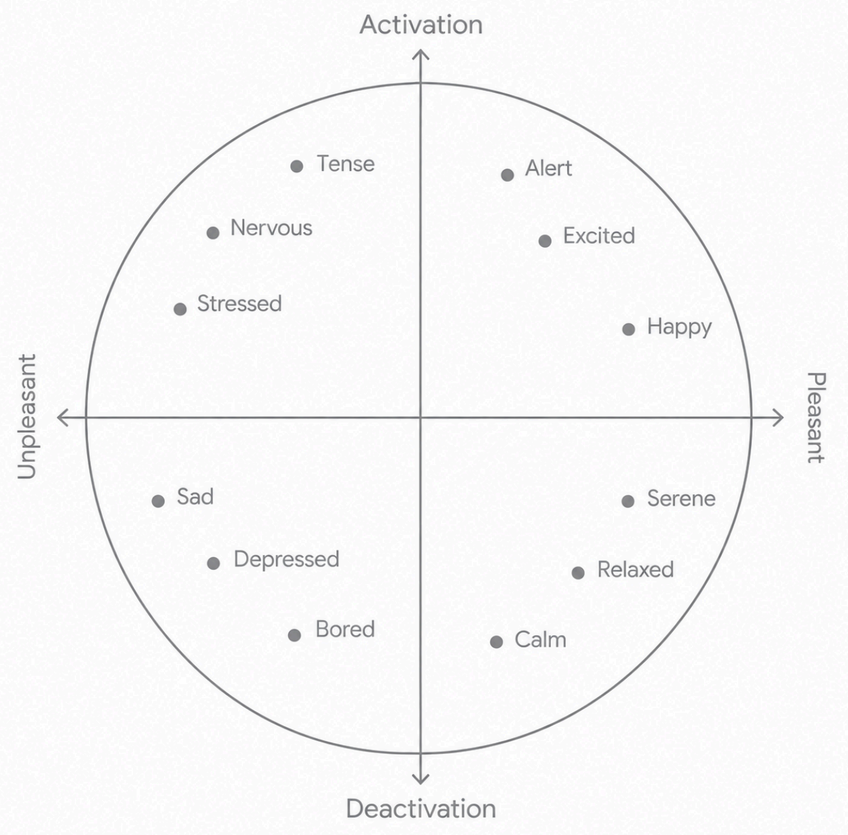


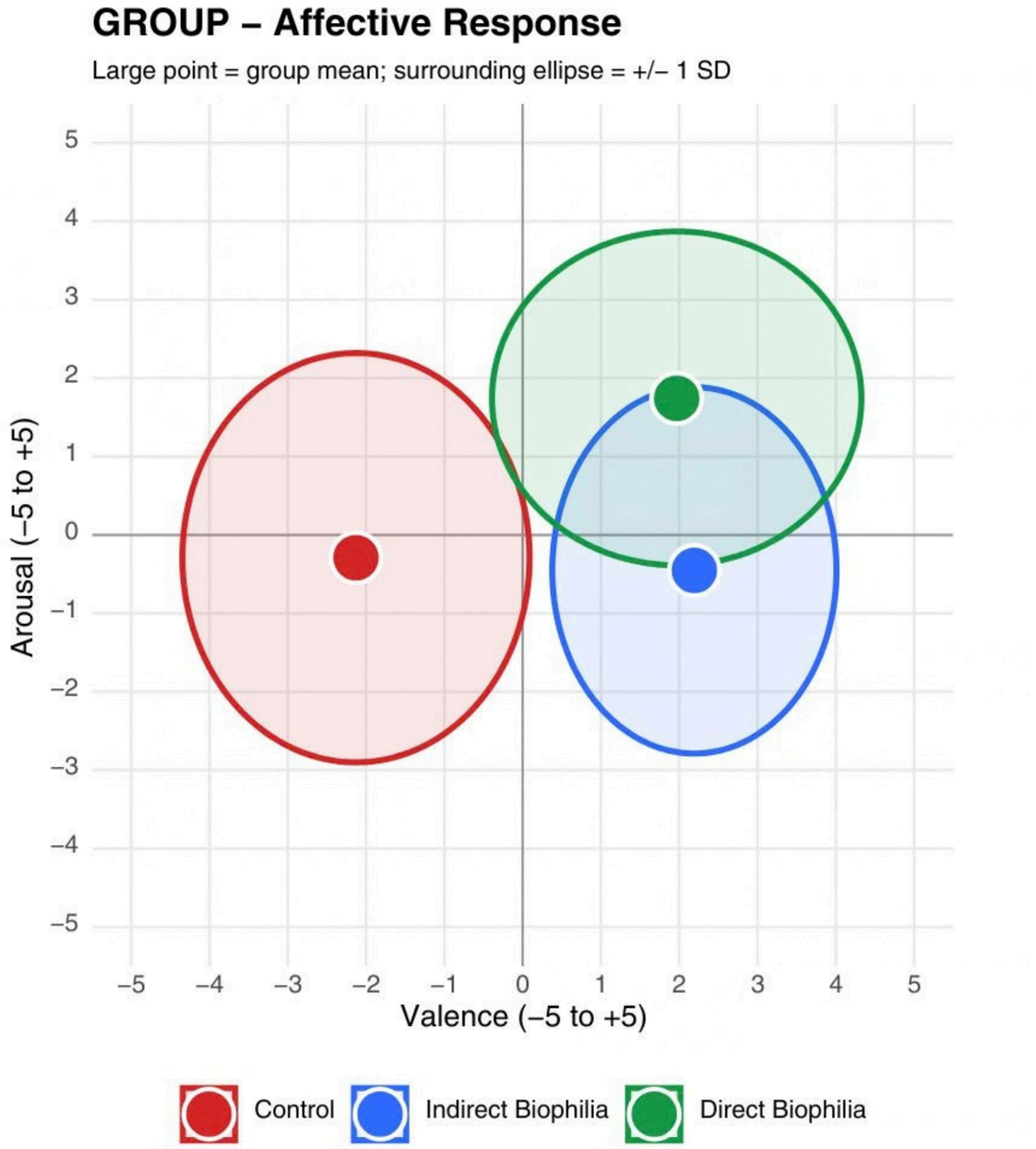
What does the data say?



Emotional Experience

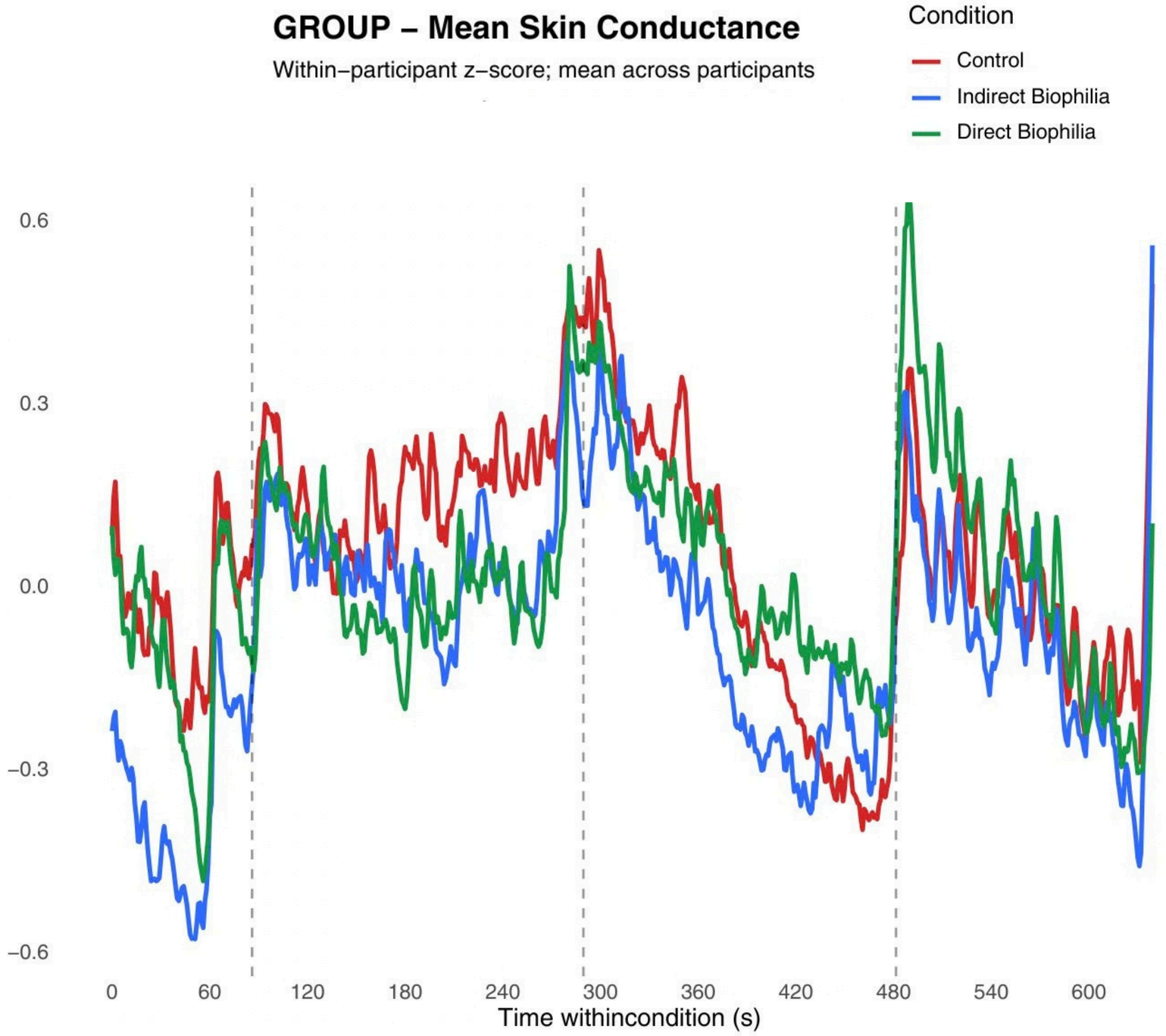
Direct Biophilia received the highest overall room rating and was associated with the most positive affective profile, combining positive valence with higher arousal.





Physiological Regulation

There were significant differences in electrodermal recovery across the environmental conditions, with Direct Biophilia showing a significantly faster decline in skin conductance during the recovery phase.

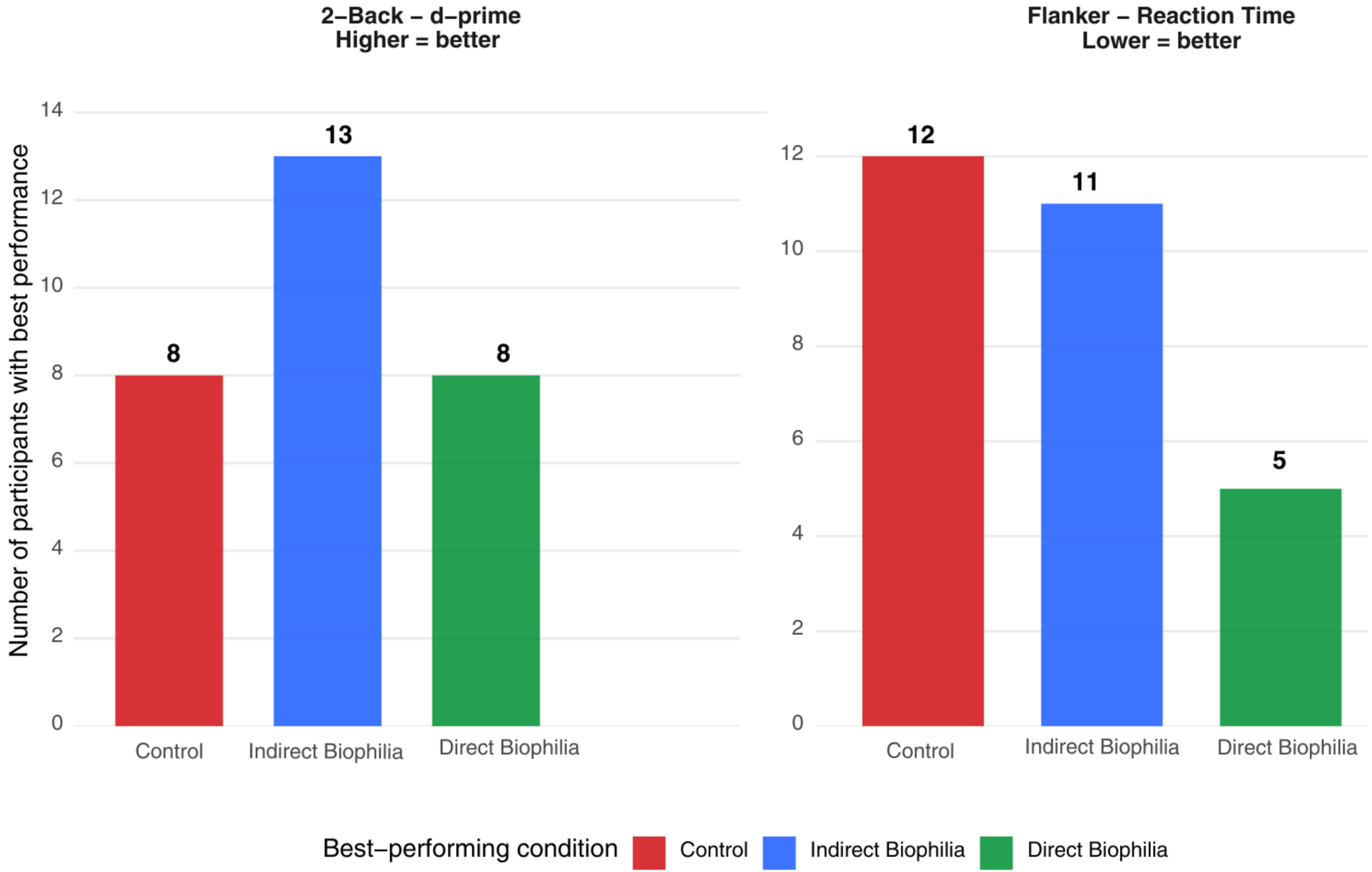


Cognitive Performance

Indirect biophilia produced the highest number of best individual 2-back performances, while direct biophilia produced the fastest flanker test responses.

Key Cognitive Outcomes

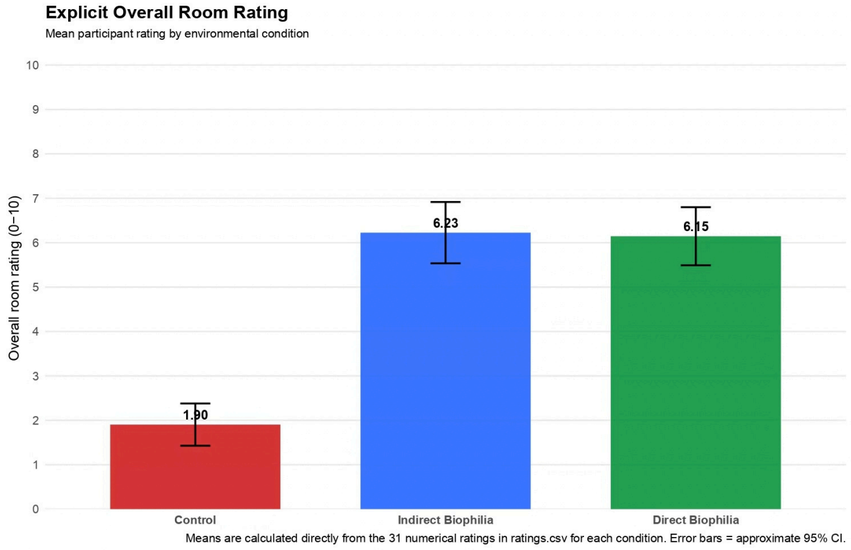
Number of participants whose best performance occurred in each environmental condition

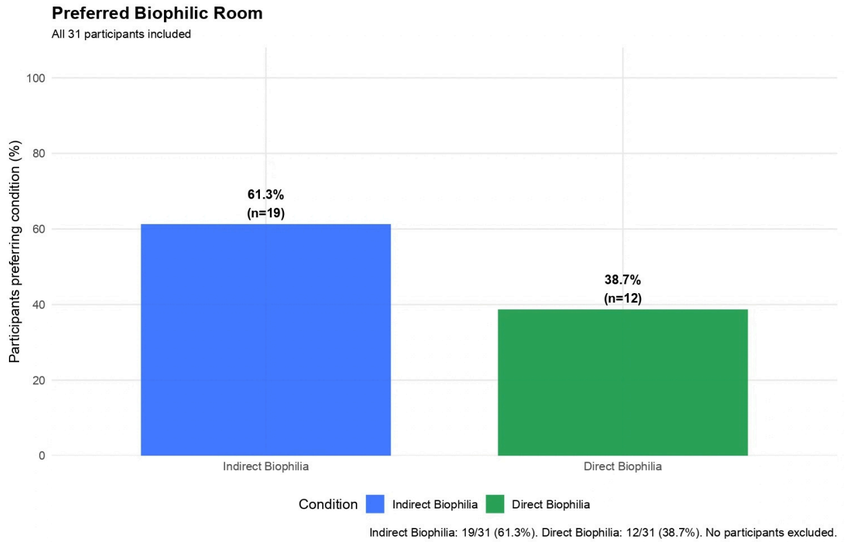


Ratings and preferences

Both spaces with direkt and indirect biophilia were rated significantly higher than the control space, with not much of a difference.

However - when asked which space participants would prefer for working, most of them chose the wooden space (indirect biophilia).





Key Take Aways







There is no neutral space

Biophilic design is one pathway to salutogenic architecture.