

LiquidView™

Transform your space and wellness
with Digital Windows

Understanding the Physiological Responses to Different Types of Content Displayed on LiquidView Digital Windows

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Introduction

Scientific studies have long documented [3] the positive impacts of bringing nature indoors on physical and mental health. Some theories propose that merely having a window in the workplace provides stress relief for workers [1]. Studies examining biophilic design conclude that exposure to indoor nature and window views relieve stress and improve both physical and mental health outcomes [2].

The problem is that most people at home, school, or work are limited by a building's architecture or their geographical location. Densely built environments, like urban areas, have large populations with little to no opportunity for views other than the building next door.

To solve this, LiquidView has worked with architects, interior designers, and the IDEO design team to create Digital Windows, which are comprised of an individual or multiple 4K HDR displays featuring high resolution views from around the world. Each view location is scouted to work for a 24 hour view and the height of the camera, lens, and perspective help "trick the brain", which validates the expected outcome of positive impact on physical and mental wellness. The views are synchronized to the time of day where the Digital Window is being used, so sunrise and sunset times are always accurate every day of the year.

Will the Digital Windows have the same effect on health and wellness as the windows in the previously mentioned studies? A new, ongoing study by Stanford University is exploring the impact LiquidView Digital Windows have on human physiological responses to different types of light. If the expected outcomes are proven, it will have a significant impact on architecture and design in both residential and commercial spaces.

The Zeitzer Circadian Research Lab at Stanford University studies the use of light and its impact on sleep, circadian rhythms, cardiovascular function, endocrine activity, balance, and cognition.

The initial results suggest that exposure to LiquidView Digital Windows improves mental health and well being.

**-Dr. Jamie Zeitzer
Stanford University**



LiquidView Digital Windows at the Zeitzer Circadian Research Lab

Principal Researchers

Jamie Zeitzer, Ph.D.
Associate Professor of Psychiatry
and Behavioral Sciences
Stanford University

Maira Karan, Ph.D.
Postdoctoral Fellow
Zeitzer Circadian Research Lab
Department of Psychiatry & Behavioral
Sciences
Stanford University

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Materials and Methods

In the study, researchers hypothesized that viewing the Digital Window display - which includes sounds inherent to the chosen location - would make the participant calmer, more relaxed, and overall happier than before they observed the 24 hour view. They posit that the location of the chosen view, as well as any unpredictable movement throughout the scene also contribute to the positive change in mood of the participants.

The study environment is a single room, in which there are no windows, and all of the ambient light is controlled by the study team from outside of the room.

Survey Population

The study population includes adults aged 18-60 years who are free of diabetes, acute medical or psychiatric conditions, and medications impacting mood and vision. Study participants were recruited from the Palo Alto metropolitan area, with the ability to travel to the lab.

Baseline Measurement

Participants are asked to sit in a comfortable chair facing a wall on which an 11.5-foot wide panoramic LiquidView virtual window is installed, and they are fitted with EEG electrodes on their scalp, fingertip cuffs for continuous blood pressure monitoring, chest EKG, and fingertip skin conductance electrodes. Room lighting is approximately 50 lux - dim room light similar to what one would experience in a living room - in the horizontal angle of gaze.

For approximately five minutes, participants are asked to sit quietly with no distraction or interactions. A baseline recording of physiologic signals will then be taken for approximately ten minutes. After this recording, participants complete a Positive and Negative Affect Schedule - Short Form (PANAS-SF) to assess current mood.

Outcome Measures

After the baseline recording, participants will then experience different blocks of light exposure, including video, still image, random content, and white light, in a randomized order for approximately 90 minutes. Each block will contain a different study condition. Between blocks, brief questionnaires concerning mood (PANAS-SF) and self-reported verisimilitude of the visual stimuli will be administered.

Measures & Questionnaires:

- Center for Epidemiologic Studies - Depression Scale (CES-D)
- Emotion Regulation Questionnaire
- Difficulties in Emotion Regulation Scale
- Perceived Stress Scale
- Tellegen Absorption Scale
- ITC-Sense of Presence Inventory
- Varieties of Inner Speech Questionnaire
- Cognitive Flexibility Inventory
- State Trait Anxiety Inventory

Study Conditions:

- Still image from LiquidView - the view contains no movement
- Scrambled view - contains the same pixels as the still image but the pixels are scrambled
- LiquidView video content - shot on location in 8K

Physiologic Signals:

- Heart rate
- Electrodermal activity (EDA)
- Blood Pressure
- Brainwave activity



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Discussion

Expected Outcome

The researchers postulated that when study participants are in front of a LiquidView Digital Window, they will have reduced heart rate, greater heart rate variability, which is associated with better health. They also looked for lower electrodermal activity, as well as alpha brainwave activity, which is more associated with being calm and with the mind being idle.

Results

The study shows that, when exposed to the LiquidView Digital Window, the participants' physiological and emotional response is measurably affected. Study participants reacted to the LiquidView Digital Windows, reporting they felt as if they are really looking out of a window by the seaside and viewing a lovely beach. Participants also reported a calmer sense of well being and measuring a reduced heart rate and electrodermal activity (EDA).

A decrease in EDA by over 40% suggests a calmer, more relaxed state, indicating that LiquidView has the potential to induce relaxation. Additionally, heart rate appears to be slightly lowered - by approximately 4 beats per minute - during LiquidView exposure. Further research is underway to determine the association between physiology and emotion measures in relation to LiquidView.

Preliminary results from the study indicate that exposure to LiquidView leads to a significant 46.5% reduction in the participants' electrodermal activity (EDA), indicating a calmer, more relaxed state.

**-Maira Karan, PhD
Stanford University**

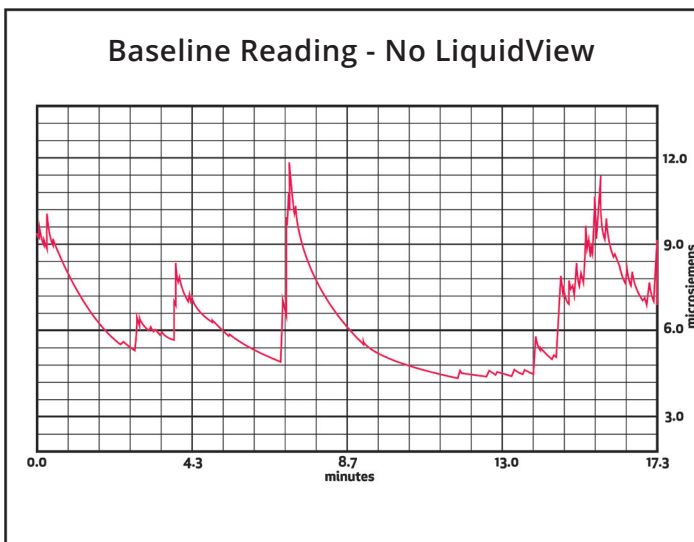


Chart 1 shows baseline reading to electrodermal activity (EDA) before the participant looked at LiquidView windows. It goes up to almost 12 then back down to around 5, which is normal, as people's thoughts cause different reactions.

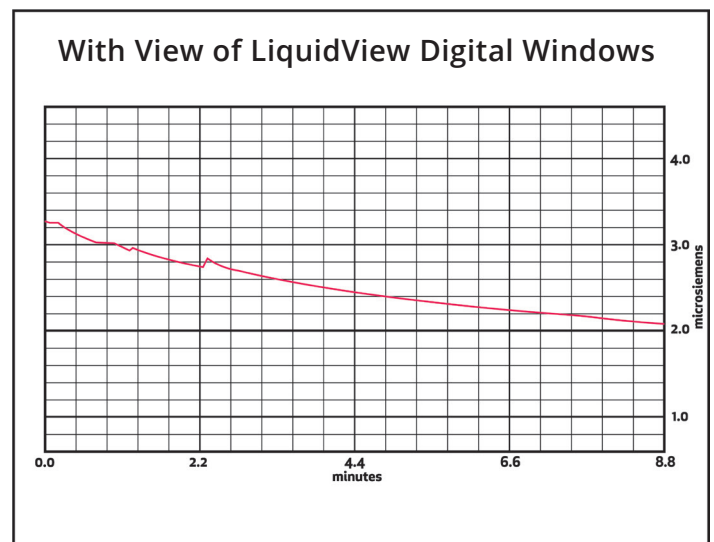


Chart 2 shows when the participant is looking at the LiquidView Digital Window. The Electrodermal Activity (EDA) decreases and no longer shows any large swings, as indicated by over 40% reduction in EDA. The Digital Window is calming the nervous system.

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Summary

LiquidView is a pioneer in digital views. The Digital Windows bring the beauty of nature to indoor spaces, offering proven health benefits similar to those experienced while being by an actual window.

The studies at Stanford's Zeitzer Circadian Research Lab are showing a calmer physiological response in participants when exposed to the views in Liquid View Digital Windows. The pronounced decrease in electrodermal activity has been linked with a calm disposition, a more relaxed mood, and a more positive mood overall.

Study participants across the board have reported that the Digital Window view and associated sounds are so realistic they feel as if they are actually at the location of the view, like the beach. The high quality production and HDR displays create the impression of being next to an actual window. It is a window to a world that may not be right outside, but participants feel like they are experiencing it in real time.

So if we can see changes in physiology that correlate with our changes in emotion, that gives us really good evidence that looking at this actually is changing your biology. That's kind of the critical thing. You look at the scene. You actually feel better. And it's not just a subjective thing. We're actually seeing changes in your biology that confirm that both how you're feeling and how your body is responding to it is a real thing.

-Jamie Zeitzer, PhD

References

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Contacts

For LiquidView:

Mitch Braff
CEO and Founder, LiquidView
mitch@theliquidview.com

Evan Kletter
VP of Health Evidence, LiquidView
evan@theliquidview.com

For Stanford University Zeitzer Circadian Research Lab:

Dr. Jamie Zeitzer, Associate Professor of Psychiatry and Behavioral Sciences
jzeitzer@stanford.edu

Dr. Maira Karan, Postdoctoral Fellow, Psychiatry and Behavioral Sciences
mkaran@stanford.edu