A Room With a "Fake" View: Installing Digital Windows in Windowless Offices

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ABSTRACT

As cities become overpopulated and we explore deep seas and outer space, humans will be faced with the inevitable situation of living and working in small spaces that are visually monotonous. It is thus important to understand the psychological effects that enclosed spaces can have on people. In this study, we ran a between-subjects design experiment with people working in windowless offices by installing a digital window that featured a nature landscape video. Quantitative measures of productivity and wellbeing before and after the intervention showed that having a digital window elevated mood and happiness, but did not have a significant effect on work productivity.

CCS CONCEPTS
- Human-centered computing → Empirical studies in HCI.

KEYWORDS
digital window; presence; green space; wellbeing; enclosed space; windowless

ACM Reference Format:

1 INTRODUCTION

With urbanization, pandemic isolation, and explorations into deep seas and outer space, humans will be faced with the inevitable situation of living in small spaces. Already, urbanization has led to a massive movement of tiny homes and pod living [14], while special research frontiers such as the arctic or outer space present spatial environments that are small and enclosed. The challenges of small spaces include long periods of isolation and confinement, which lead to an array of symptoms from the physical (e.g., disturbed sleep, impaired cognitive ability), to psychological (e.g., negative affect, depression), and relational troubles [12]. Especially in environments that lack visual diversity (e.g., space, arctic regions, windowless offices, prisons), the feeling of entrapment or being in a void creates serious mental consequences.

While technologies like virtual reality have the ability to provide immersive experiences to “transport” people to other places, they are highly intrusive in terms of taking up the user’s attention. In this research, we used projection and display technology as an ambient means to augment enclosed spaces with a fake digital “window” portraying nature landscape to examine how the illusion of being in a different environment influences the wellbeing and productivity of people working in windowless offices. This was expanding on the work of Friedman et al. [5], where the researchers installed digital windows in university campus offices that showed live outdoor footage of the campus. In this study, participants reported an increase in their connection to the social community and their psychological well being. However, the digital displays used in this study were also used for work purposes, and were not a permanent architectural feature, thus in our study, we conceptualized our digital window as an interior ambient feature that would not disrupt workflow but would still be noticeable by the person occupying the space. We also aimed to quantify the effect of having such an installment.

2 RESEARCH QUESTIONS

Changing the environment to make people feel like they are in a different environment—whether that be a physical environment and/or a social environment—taps into the concept of presence. Presence is a highly discussed construct with scholars having varied definitions of what it is [3], but the heart of the concept is the feeling of “being there” [2]. It has been used mainly to describe immersion when people use virtual environments or mediated technology. Even though virtual reality can enhance presence [5], these experiences require a headset and interfere with other tasks that require visual interaction outside of the virtual reality system.

Our proposed system is a less-intrusive scenario where a digital window is placed on the wall of a room and is programmed with a video to simulate a window with a live view of a nature landscape. This window could be created with a high-resolution projection or a large physical display. This led to our decision of choosing a
nature video with a wide vision view of sky, mountain, and lake. We chose to stick to an eight hour loop video to keep it consistent with the duration of time each participant worked for.

While the windows can be programmed to display any scene, we are interested in the effect of green space. Access to green space has been shown to be associated with mental health [6] even if there is no physical activity in the green space. Seeing nature also helps with health recovery: a study on wellbeing and patients in a hospital showed that patients in a window room had shorter hospital stays [15]. Farley et. al (2001) found that people prefer places with windows with views of nature rather than non-windowed places [3].

Moreover, literature in landscape/urban planning and psychology shows a positive effect of seeing nature on happiness [9, 16]. More recent big data analyses indicate that country-level happiness is correlated to green space as detected through satellite imagery [4].

While there are limited examples, the effect of nature appears to still exist even if it is simulated [8]. For example, Radikovic’s [13] study presented a new use of display technology through an artificial window with motion parallax where participants could control the window view. The view of nature increased arousal, positive feelings, and reduced tension/other negative feelings.

While the correlation between green space and happiness is well established, they do not indicate causality. It is unclear if simulated green space (as opposed to real nature) will have the same positive effect, especially in an environment outside of the lab. Moreover, most previous studies did not focus on work environments, which is a unique context because people are not looking out the window most of the time. Thus our first research question aims to look at whether digitally-simulated greenery improves the well-being of people occupying small work spaces:

**RQ1:** Does a digital window in a windowless office improve wellbeing over time?

While beautiful green scenery can make people feel better, it is unclear how this would influence work productivity. On the one hand, it could make people more productive, but it could also distract. Our second research question thus examines the effect of the digital window on productivity:

**RQ2:** Does a digital window in a windowless office improve or deteriorate productivity over time?

### 3 METHODS

We decided to create a realistic digital window that displayed a nature video. We found a nature video that depicts a window being slightly open and bringing viewers into a scene of mountains and a lake. As the video plays, viewers will notice the slight breeze of fog that rolls in through the foreground of the video; as well as the trees and water moving in the background. Depending on the space available in the office, participants either had a large display (Figure 1) or a wall projection (Figure 2). The typical dimensions for a window ranged from three to four feet, similar to the size of windows in offices that had windows. The large display we used was a 43 inch display. We kept this size consistent with the projection.

Before starting this experiment, locations needed to be established as well as window space. A pilot test was conducted to ensure that our equipment would run smoothly as well as test the quality of our nature scene display. This involved two participants that were part of a student club organization. The students remained in a windowless office for four to three hours of a day in a week. At the end of the week, each participant filled out an online survey about their experience. Based on the pilot study feedback we changed the window by including a window frame since the test participants did not perceive the image to be a “digital window”.

Over the course of a week, we studied each participant in an enclosed office space. To recruit our participants we searched for offices that were windowless and emailed the locations to verify if we could proceed with the testing. All of the participants were in
their office for majority of the day working on their computers. Day one, we conducted the study with two participants that were located in the same office room working for Audio Video Engineering, however, they were separated by cubicles. Given the environment and condition of lighting system in the office room, we decided to use a TV Screen in addition to the projector. Participant 2 received a projection of the digital window. While participant 1 received a television projection of the window. Each participant was also required to sign a consent form that had been approved by IRB, and had to take a short survey before and after the intervention. Along with this, participants were told they would receive a 40 USD gift card for their participation. During this time, we would turn the projections on every morning and turned off at the end of their working hours.

After seven days had passed, we gave each participant the post survey similar to the initial survey and conducted individual exit interviews. The interviews were audio recorded and transcribed. The process was repeated over the next three weeks, which included a total of seven participants to our study. Each participant was exposed to the digital window for seven days.

3.1 Measures

We had two measures related to productivity: productivity and flow. Productivity was a 10-item scale from Endicott Work Productivity Scale [2] that indicated the frequency of activities that were unproductive, including items such as “In the past week, I have found it difficult to concentrate on the task at hand” and “In the past week, I found myself daydreaming, worrying or staring into space when I should have been working.” The answer options ranged from 1 (never) to 5 (always). The 10 items were added to create a score; the higher score indicates lower productivity.

Flow is a 4-item scale from Flow State Scale [11] that indicated measure of immersion in work, including items such as “When I’m in the office, time seems to alter (either slowed down or speed up)” and “When I’m in the office my attention is focused entirely on what I was doing”. The answer options ranged from 1 (strongly disagree) to 5 (strongly agree). The 4 items were added together and divided by the number of questions; the higher score indicates a greater work flow.

We had three measures of wellbeing, all based on established measures: happiness, mood, and anxiety.

Happiness was a 7-item scale from Oxford Happiness Questionnaire [7] that indicated the frequency of happiness, including items such as “At work, I find most things amusing” and “At work, I am intensely interested in doing other things”. The answer options ranged from 1 (strongly disagree) to 5 (strongly agree). The 7 items were added together and divided by the number of questions; the higher score indicates higher levels of happiness.

Mood was a 6-item scale from Mood Scale (PHQ) [10] that indicated the mood of participants in that given week, including items such as “I find myself moving slowly at work” and “I find myself being fidgety or restlessness at work.” Participants had to rate the items from 0 (Not at all) to 3 (Nearly every day). The 6 items were added to create a total score; the higher score indicates a lower or worse level of mood.

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Table 1: Type of office that participants primarily worked in during their work day.

Anxiety was a 4-item scale from Hamilton Anxiety Scale [1] that indicated anxiety levels of participants in that given week, including items such as “I have feelings of tension, fatigue, startle response, moved to tears easily, trembling, feelings of restlessness, inability to relax when I am at work” and “I have loss of interest, lack of pleasure in hobbies, depression, early waking, diurnal swing when I am at work”. The answer options ranged from 0 (not present) to 4 (very severe). The 4 items were added together to create a total score; the higher score indicates a higher level of anxiety.

4 RESULTS

4.1 Statistical Results

Productivity (lower score indicates higher productivity) went up from before the window intervention (M= 19.85, SD= 5.58) to after the intervention (M= 16.28, SD= 2.05). However, the difference was not statistically significant, t(6)=1.53, p=.178.

Flow increased from before the window intervention (M = 4.10, SD = .57) to after the intervention (M = 4.14, SD = .63). However, the difference was not statistically significant, t(6)= .125, p = .905.

Sense of happiness increased from before the window intervention (M = 4.14, SD = .56) to after the window intervention (M = 4.71, SD = .42). The difference was statistically significant, t(6)= -2.7, p=.036.

Mood (lower score indicates better mood) decreased from before the window intervention (M=8.9, SD=2.8) to after the window intervention (M = 1, SD = 1.5). The difference was statistically significant, t(6) = 11.15, p= 0.

Anxiety (higher score indicates higher level of anxiety) decreased from before the window intervention (M=2.6, SD= 2.07) to after the window intervention (M=1.42, SD = 1.4). However, the difference was not statistically significant, t(6)=1.7, p=.139.

4.2 Interview Results

Participants varied in response to their experience with the digital window but were generally excited and happy about it. Q1 explored whether the participants felt that the window was realistic. P3 and P5 reported that the window felt realistic but the others did not feel like the window was a real window. The type of technology (display or projection) did not seem to matter in terms of reality; in other words, all participants were acutely aware that the scenery was not real.

Q2 asked what kinds of nature images will be good and preferred for the digital window. Participants’ answers varied—some
preferred a beach scene or a blue sky with clouds. Others wanted to see animals. A couple participants also added that they would like to hear audio of nature as well. P5 and P6 mentioned that they wanted to hear beach sounds or cricket chirping sounds. The desired nature audio, again, varied by individual.

Q3 asked participants about what they would want to change if they were to continue using the digital window. P1, P7 wanted to have the window with a moving narrative image so that it followed the time of the day. There would be a connection to the atmosphere when it’s time to leave, for example, if it got dark outside as it got closer to the end of the day. In this case, a moving image is better than a still image. When asked about the format and style of the display, all participants except for P2 preferred the projected image to the large display.

Q4 explored whether after a one-week experiment, how participants’ reliance and dependence would lead to a change in the environment of a digital window, for example, how much desire was there to have it open for longer. Six participants expressed significantly positive feelings about the development of the environment and desired to have the window for longer than seven days. P1 explains that “I think it made a noticeable difference within just a week. I guess if it was a longer study, maybe I could see how it would affect busy times at the office.” P4 commented, “I think it helped me relax and calmed my mood sometimes.”

Q5 asked participants about their favorite part of the window. Most participants enjoyed the contents of nature video rather than the method of display. So they felt the presence of being close to the outdoors even when they are in a windowless or basement office. P2 comment, “It was nice to walk into my office and see flowing trees/mountains. I guess the outdoor element, and just having a bit of outdoors down here in basement land.”

Q6 asked participants about the most noticeable changes caused by the digital window. All the participants reported improvements to their work environment. Despite the statistical results not being significant, in the interviews, some participants said that it improved their work itself as well as emotionally. This relates to our first research questions (Does a digital window in a windowless office improve wellbeing over time?). P3 stated, “It can only improve your efficiency. Like I would say it improved my mood a bit because I was smiling when everybody was coming.” P4 noted that the digital window reduced stress. “Before, when I used to get bored at work, I only had the wall to stare at but with the window, it helped me think of something constructive to do as well as calming my mood when I get stressed or overwhelmed.”

Q7 asked what was their least favorite part of the digital window. Most of the participants mentioned a desire for technical improvements, i.e., getting more realistic images. P7 mentioned that the frame of window image distracts seeing the nature image. In general, P7 did not experience any strong positive or negative effects of the digital window. From this response we found that there is no correlation between the improvement and deterioration of a participants wellbeing over time (RQ2). He introduced himself as someone who likes to get work done and go home, and that is all he cares about during the work time so he is less concerned about the work environment.

5 DISCUSSION

We found that even though participants did not think the window was realistic, the video of nature that was played on the digital windows still had a positive effect on their mood and overall happiness. Although there was no statistical effect for improvement in productivity, interviews suggest that the effects on productivity are quite variable, because some people found that having the window made them very productive and others not. This difference in individual preference may also have dampened the overall effect of the digital window because our intervention showed a mountain and lake scene and people had different opinions on the type of scene they wanted to see. If anything, the positive effect we found with the mountain scene indicates that the effect could be even more amplified with proper customization.

6 CONCLUSION

Even if they knew the digital window was not real, having a digital projection of nature scenery on the wall of a windowless office increased the sense of happiness and mood of people working there. This technically simple design may improve the wellness of people living and working in enclosed spaces by giving them an alternative representation of a window by taking the physical aspect of a window frame and combining it with a virtual display to imitate an actual window. This experiment has increased the implications of environment for humans wellbeing overtime.

7 FUTURE WORK

Based on this preliminary study, future work should engage more participants and also explore more long-term effects of having a digital window, since this intervention was only one week. Experiments including other nature-related modalities, such as olfactory and audio stimuli, may lead to further insights about how nature influences wellbeing.

REFERENCES


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