MINOR CHANGE FOR MAJOR IMPACT: HOW CAN MINOR CHANGES IN THE DAILY URBAN ENVIRONMENT IMPACT AN ASPECT OF PSYCHO–PHYSIOLOGICAL HEALTH?

Abstract

Attention Restoration Theory indicates that sustained attention is one of the critical factors for successful cognitive functioning. This study proposes that micro-interactions with natural green elements would increase the level of attention in individuals. This study compared the results of Sustained Attention to Response Task (SART) from 52 residents of a high-rise residential building. Participants were randomly assigned to experience one of the two versions as a 3D virtual reality environment of a building's threshold design, one with and one without natural green elements. The experience was via immersive virtual reality (VR) goggles. Participants completed the SART twice. Once before experiencing the threshold to establish a baseline of attention and once after. The results indicate that those who interacted with natural green elements in the building threshold showed significant improvement in score and demonstrated less cognitive errors compared to those who interacted with a threshold with no natural green elements. We can argue that this research outcome tends to indicate that micro-interaction with natural green elements can have a significant positive effect on attention restoration and sustained attention.

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Keywords

Attention restoration, sustained attention, natural green elements, threshold, virtual reality (VR)

Introduction

The urban population of the world has increased from 751 million in 1950 to 4.2 billion in 2018. Today, 55% of the world's population lives in high-density urban areas, a proportion that is expected to increase to 68% by 2050 (UN DESA, 2019).

High-density urban area usually means no front or backyards and limited access to a natural environment on the property (Beer et al., 2003; Swanwick et al., 2003; Wang et al., 2019). Densification also caused a decrease in urban green space in major cities such as Jakarta, Indonesia, and Metro Manila, Manila, between 1988 and 2014 (Nor et al., 2017). Living in these new dense cities brings a new lifestyle with it (Ryan et al., 2018). Studies have suggested that most of the urban population's time is spent at home, at work, and commuting between these two locations. It also stated that the human interaction with the natural environment is less than half an hour per day (U.S. Bureau of Labor Statistics, 2017).

Research has verified that the green landscape has the capacity to promote the cognitive functioning of the human brain and help people to recover from attentional fatigue (Keniger et al., 2013). So it is important to maximize the benefits that citizens can receive during their limited interaction with natural elements.

The current study focuses on residential complex threshold design as one of the few spaces with which urban residents interact daily. This study explores the role of green elements in residential complexes and their ability to alleviate mental fatigue and promote attention restoration.

Research Methodology

The main research question of this study is "Do the green elements utilized in a multifamily residential complex's threshold design have a positive impact on restoring residents' attention?" A quasi-experimental strategy will be used to answer the research question. This strategy is employed when it is not possible to control enough variables to establish a cause-and-effect relationship between the independent and the dependent variable with no ambiguity (Thyer, 2012).

The overview of the research methodology is illustrated in Figure 1. The research study sites are two virtual versions of an existing high-rise residential threshold that were modeled in Maya® 3D software and then exported to Unity VR platform. The sample of this study was 52 residents of the high-rise apartment that were selected through a purposive sampling method. This research is quantitative research that employs SART to collect data. The collected data was then analyzed for possible correlations.

Sustained attention is the ability of an individual for processing repetitive stimuli consciously when those are habitual. Perpetuity of a task leads attention to other distractions. SART is a validated quantitative cognitive task that measures participants' vigilance improvement as an indicator of sustained attention (Perkins et al., 2011). Recent studies by Berto (2005), and Lee et al. (2015), have used this method to measure changes in participants' attention capacity.

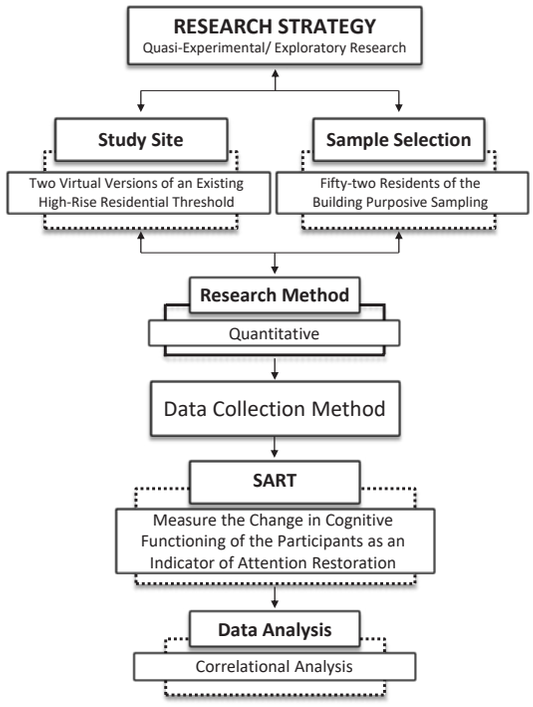

Figure 1: The overview of study methodology.

Participants took part in the study when they were coming home at the end of their workday to amplify the chance that they experienced direct attention fatigue. This would increase the potential to detect changes in their cognitive task performance. As they entered the building threshold they were asked to do the pre-SART test.

This study used a random version of SART (Johnson et al., 2008) using the E-prime. In this task participants were provided with a sequence of characters on an iPad Air and were asked to respond to every character but "G" by touching the screen as the response cue "⊗" appeared. Each individual was presented with 220 characters. 110 for each half (pre- and post-test). The order the characters appeared on the screen was the same for all participants. There were 15 and 12 presentations of the character "G" in each half of the SART. The response cue was employed to help reduce the pace/precision tradeoffs in the individuals' responding (Lee et al., 2015).

After the pre-test participants were randomly assigned and immersed via VR goggles in one of the two building threshold versions, one with and one without natural green elements. Different studies have successfully exploited different modes of virtual interaction with nature to measure changes that occurs in participants' cognitive functioning (Felsten, 2009; Van Den Berg et al., 2014; Wang et al., 2016; Jenkin et al., 2017; Chung et al., 2018; Moreno et al., 2018). Utilizing VR allowed the researcher to alter the design quickly and cost-effectively (Saedi & Boone, 2018). In this VR environment, participants engaged solely visually with natural elements.

Participants were taught how to use VR devices in separate sessions and then were asked to walk into the threshold and get to the elevator in a direct manner at a normal pace. Participants used Oculus Quest for the VR experience. Participants had to press the main start button on the controller to enter the VR environment and they had to push the same button again as soon as they got to the elevator to record their duration of experience.

During the experiment, 18 people spent more than 55 seconds to finish the immersion part of the study. The span between the starting point and the end point of the threshold to access the elevator was 71 meters. According to Schimpl et al. (2011), in this study the overall average of walking speed for the participants was considered to be 1.34 m/s. Thus, those who spent more than 53 seconds finishing the immersion section of the study were walking at a slower than average pace and therefore were considered to be engaging with the environment more than what would be expected and were eliminated from the data analysis. The final participants' group size was 34.

After experiencing the threshold, participants took the post-SART test. The results of the pre- and post-tests were statistically analyzed to see if there was a meaningful difference in the results.

Results

Experiencing the threshold with natural green elements for less than 53 seconds was associated with a more consistent pattern of responding, suggesting higher sustained attention, measured by the standard deviation in response time [F (1,34) = 13.01, p < .002]. There was no baseline difference between participants of the two groups [F (1,34) = 0.00, p= 0.958, r = 0.00], but there was a significant difference in performance after experiencing two different designs [F (1,34) = 4.91, p = 0.023, r = 0.20]. Participants in the threshold with natural green elements showed less response variability post-treatment [F (1,34) = 5.10, p = 0.024, r = 0.20], whereas those in the threshold with no natural green elements showed a significant increase in response variability [F (1, 34) = 7.81, p = 0.006, r = 0.22].

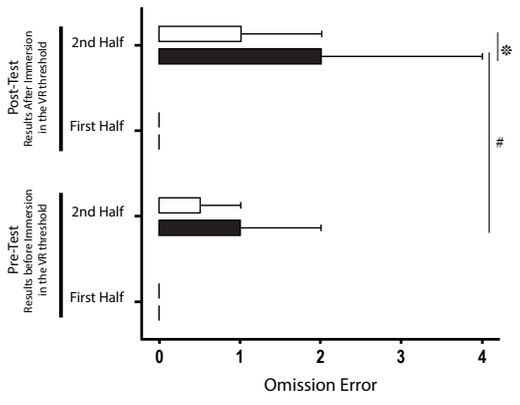

Figure 2: Boxplot of the median and variability of the number of omission errors. Threshold without natural elements (black boxes) and with natural elements (white boxes). Data shown for the 1st and 2nd half pre-test and the 1st and 2nd half post-test. Asterisk indicates a significant difference between participants immersed in the plain and vegetated threshold (p =.043). Hash indicates a significant difference, for participants immersed in the plain threshold, who made significantly more errors in the 2nd half task from baseline to post-treatment (p <.001).

The results were analyzed for the omission (participants failed to respond to non-target digits) and commission errors (incorrectly responded to the target digit). It was observed that after experiencing the threshold with natural green elements, participants made less omission errors compared to participants experiencing the threshold with no natural green elements. In the pre-treatment task, there was no significant difference between participants in both groups and at baseline the two groups made a similar number of omission errors [U = 2654, p = 0.398, r = -.019].

In the post-treatment task, however, the group with no natural green elements made significantly more omission errors than the group with natural green elements [U = 2315, p = 0.043, r = -0.13] (Figure 2).

The study did not observe differences in commission errors between the groups at baseline [1st half, U = 2448, p = 0.163, r = -0.07, 2nd half, U = 2468, p = 0.188, r = -0.06], or after viewing the scene [1st half, U = 2372, p = 0.095, r = -0.12, 2nd half, U = 2359, p = 0.095, r = -0.12]. This suggests that there was no difference in impulsive responding.

To make sure that the outcomes for omission and commission errors were not based on the significant difference in the participants' response speed to the task, the study analyzed the speed of the participants' responses. There was no difference in mean response time for participants in both groups [F (1,34) = 0.11, P = 0.749].

Conclusion

Results demonstrated that after spending approximately 50 seconds in a virtual high-rise residential building threshold with natural green elements, residents obtained higher scores in SART. Given the connection between natural environment and attention restoration, the results indicate that micro-restorative interactions with natural green elements in an indoor environment may induce the similar psychological responses in participants as interacting with much larger natural environments. This result shows that individuals may benefit from some of the positive impacts of interacting with nature even if the interaction is of short duration and a part of their urban environment. This study indicates that a small change in an environment that people participate in every day has the potential for significant positive impact on their attention restoration and therefore, their mental health.

Besides the many mental health benefits that actual vegetation can provide, our results also shed light on the possibilities for using virtual environments to maximize opportunities for viewing nature during succinct micro-breaks in daily lives.

One of the main limitations of the research reported on in this paper is a small sample size which does not allow for the analysis of variables such as age, gender, and other factors. Efforts are being made to significantly increase participant numbers and examine these factors in future works.

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