5-2022

Architecture as Stress Relief: What Makes a Meditative Space?

Angela Brown
University of Arkansas, Fayetteville

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Angela Brown

University of Arkansas

Fay Jones School of Architecture and Design

Department of Architecture

Capstone Advisor:

Dr. Jennifer Webb, Department of Interior Design

Capstone Committee:

Dr. Jisun Lee, Department of Interior Design

Frank Jacobus, Department of Architecture

Charles Sharpless, Department of Interior Design

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Abstract

Stress is a prevalent issue today. People can become stressed or overstimulated for various reasons, whether it be due to their physical environment, their physiological nature, psychological factors, or a combination. Although the causes of stress for our prehistoric ancestors were mostly periodic events such as predators or weather, modern-day stressors are often persistent and environmental, leading to chronic stress. Also, in today's world of constant new information and stimulation, especially in urban locations, sensory overload is common. Additionally, the COVID-19 pandemic and its mental effects have brought new attention to the interaction between physical environment and well-being. The prevalence of stress and other mental health challenges due to the pandemic is an ongoing global issue, and there has been speculation about how architecture might be affected by and could respond to this. When considering these issues, the psychological effects of architecture and design become even more relevant.

This capstone project explores the interactions of stress, architectural design elements, and perception. Taking inspiration from previous research studies on similar topics, this study focused on designed interior spaces of meditation and retreat and their impact on stress. Participants in the study completed an anonymous questionnaire that measured their perceived level of stress. Then, participants viewed eight images of designed interior spaces while completing rating scales for each image. This analysis focused on spaces of meditation and retreat in terms of the experiential qualities of the architecture in order to come to conclusions about what qualities of architecture may influence the effects of stress and overstimulation. This project is meant to lead to a greater understanding of how architecture can moderate stress and

have positive psychological effects on people. This project is designed to provide insight into the design of spaces that moderate stress.

Introduction

I have always enjoyed "quiet time," and having a quiet place where I could read or do something creative has always been important to me. As I have matured, I now can understand the restorative power of such "quiet places," whether they are created by the user or someone else. I have realized the importance of the design of places for retreat, meditation, and renewal in today's world of persistent stressors and constant stimulation. My architectural education led me to begin thinking about the design of spaces for this purpose and how they are perceived by the people that seek them out and use them.

Stress is a prevalent issue today. People can become stressed or overstimulated for various reasons, whether it be due to their physical environment, their physiological nature, psychological factors, or a combination. Although the causes of stress for our prehistoric ancestors were mostly periodic events such as predators or weather, modern-day stressors are often persistent and environmental and can lead to chronic stress.[1] Also, in today's world of constant new information and stimulation, especially in urban locations, sensory overload is common.[2] Additionally, the COVID-19 pandemic and its effects have brought new attention to the interaction between physical environment and well-being.[3] Therefore, the consideration of sensory experience in architectural spaces of meditation and retreat is important regarding today's world of increased stimuli and stressors.

[1] Natali Ricci, "The Psychological Impact of Architectural Design," (Thesis diss., Claremont Mckenna College, 2018), 8.
[2] Naresh Malhotra, "Information and Sensory Overload, Abstract," *Psychology and Marketing (Pre-1986)* 1, no. 3 (1984): 9.
[3] Nelida Quintero, "Design and Contagion: Well-Being and the Physical Environment during the COVID-19 Pandemic," *Journal of Urban Design and Mental Health* 6, no. 2 (2020).

The theoretical context of this project is James Gibson's theory of affordances, which discusses how people perceive their environments.[4] The theory states that the environment is perceived in terms of affordances: opportunities for action that are in the environment and do not depend on the observer's mental state.[5] The environmental information is not imposed, but perceived, obtained, and used by an active observer.[6] The concept of affordances can lead to a greater understanding of the interaction between people and the built environment, especially in terms of architectural attributes.[7] Affordance theory "provides an alternate way of viewing the design of environments emphasizing the complementarity of the relationship between environments and their users."[8] The concept of affordances can provide architectural design with a "rigorous theoretical basis" because it connects people with the built environment and "explains why and how users behave the way they do."[9]

The purpose of this research is to evaluate how interior spaces, specifically spaces of meditation and retreat, are perceived by people with different levels of stress.

The specific objective is to explore the relationship between a person's stress level and the evaluation of design attributes and experiential qualities of a space intended to be meditative and calming.

H1: Evaluation of design attributes from stressful to calming will vary as a function of stress level.

[4] Jonathan R. A. Maier and Georges M. Fadel, "An Affordance-Based Approach to Architectural Theory, Design, and Practice," *Design Studies* 30, no. 4 (July 2009): 395.
[5] Rob Withagen et al., "Affordances Can Invite Behavior: Reconsidering the Relationship Between Affordances and Agency," *New Ideas in Psychology* 30 (2012): 251.
[6] Withagen et al., "Affordances," 252.
[7] Maier and Fadel, "Approach," 394.
[8] Maier and Fadel, "Approach," 404.
[9] Maier and Fadel, "Approach," 410.

H2: Evaluation of design attributes from stressful to calming will be correlated to scores for natural, beautiful, relaxing, uplifting, comfortable, and complex.

A second objective is to examine whether there are differences between how design students and non-design students perceive interior spaces that are designed to be meditative.

H3: Evaluation of design attributes from stressful to calming will vary as a function of college major.

This project was undertaken to learn how architecture, specifically meditation spaces or other spaces of retreat, is perceived by users with different levels of stress. This project may inform the decisions designers make in creating meditative spaces for maximum effect on the users, and it is meant to provide insight into the design of spaces that moderate stress.

Background

In this section, existing research on the causes and effects of stress, qualities of architecture that have positive psychological effects on people, and the theory of affordances will be reviewed. The first concept to explore is stress, sensory overload, and the mental health effects of the COVID-19 pandemic. The second concept is the psychology of architecture, specifically experiential qualities of space such as shape, color, and light and how those qualities of space affect their occupants. The third concept is the theory of affordances, which provides a way of viewing the design of environments that emphasizes the person-environment relationship and explains user behavior.[10]

[10] Maier and Fadel, "Approach," 404.

Stress, Sensory Overload, COVID-19 and Mental Health

People can become stressed or overstimulated for various reasons, whether it be due to their physical environment, their physiological nature, psychological factors, or a combination. In prehistoric times, stressors for our ancestors were irregular events. However, modern-day causes of stress are often persistent, which can lead to chronic stress.[11] A person becomes stressed "when there is an imbalance between environmental demands and individual coping resources."[12] When a person perceives danger, different areas of the brain communicate with each other, which causes increases in heart rate, respiratory rate, and blood pressure, and the person's senses become sharper. The body stays on high alert until the stress passes.[13] Naresh Malhotra argues that each person "has a limited capacity to absorb and process information" and when that limit is exceeded so that the brain cannot handle the stimuli, sensory overload occurs. Sensory overload is common in urban environments where there is more noise, more people, and more information that impacts one's senses daily.[14] People who live in urban environments are 21 percent more likely to have anxiety disorders and 39 percent more likely to have mood disorders than people who live in rural areas.[15] Sensory overload causes impaired work performance, as well as increased heart rate and breathing rate.[16]

Additionally, the COVID-19 pandemic and its effects on mental health has brought new attention to the interaction between physical environment and well-being. The pandemic and the

[11] Ricci, "Psychological Impact," 8.
[12] Anders Q. Nyrud and Tina Bringslimark, "Is Interior Wood Use Psychologically Beneficial? A Review of Psychological Responses Toward Wood," *Wood and Fiber Science* 42, no. 2 (2010): 202.
[13] "Understanding the Stress Response," *Harvard Medical School*, Harvard Health Publishing, https://www.health.harvard.edu/staying-healthy/understanding-the-stress-response
[14] Malhotra, "Sensory Overload."
[15] Jaap Peen et al., "The Current Status of Urban-Rural Differences in Psychiatric Disorders," *Acta Psychiatrica Scandinavica* 121 (2010): 84.
[16] Z. J. Lipowski, "Sensory Overloads, Information Overloads and Behavior," *Psychotherapy and Psychosomatics* 23, no. 1/6 (1974): 267.

changes in society that resulted have greatly impacted people's mental health. Due to the pandemic, new challenges, financial and otherwise, have arisen, including access to mental health care. Furthermore, "stress and worry about contracting the virus, coupled with job losses, loss of childcare, as well as the devastating loss of loved ones due to COVID-19" are just a few factors that have contributed to the pandemic's toll on mental health.[17] In March 2020, 32 percent of American adults said that stress and worry due to COVID-19 was negatively impacting their mental health; that number rose to 53 percent in July 2020.[18] According to a study by Boston College researchers, by November 2020, reports of depression increased by 44 percent and anxiety by 50 percent: "rates six times higher than 2019."[19] Younger adults have been hardest hit: 61 percent of American adults aged 18 to 29 reported feelings of depression, while 65 percent reported feelings of anxiety.[20] Another April 2021 study found that 49 percent of Black adults, 48 percent of White adults, and 43 percent of Hispanic adults reported a negative impact on their mental health due to the pandemic. Three in ten Black adults (31 percent) and a quarter of Hispanic (25 percent) and White adults (23 percent) said it has had a "major impact."[21] Mental health disruptions have been higher among women than men: "More than half of women overall (55 percent) report a negative impact on their mental health due to the coronavirus pandemic, compared to about four in ten men (39 percent) who report the same."[22]

The study also found that 53 percent of Americans who know someone who has died from COVID report that "their mental health has been impacted in at least a minor way"

[17] Audrey Kearney et al., "Mental Health Impact of the COVID-19 Pandemic: An Update," *Kaiser Family Foundation*, Kaiser Family Foundation, 2021, https://www.kff.org/coronavirus-covid-19/poll-finding/mental-health-impact-of-the-covid-19-pandemic/
[18] Keamey et al., "Mental Health Impact."
[19] Ed Hayward, "COVID-19's Toll on Mental Health," *Boston College News*, Trustees of Boston College, 2021, https://www.bc.edu/bc-web/bcnews/campus-community/faculty/anxiety-and-stress-spike-during-pandemic.html
[20] Hayward, "COVID-19's Toll."
[21] Keamey et al., "Mental Health Impact."
[22] Keamey et al., "Mental Health Impact."

compared to 44 percent of those who have not personally known someone who has died.[23] Additionally, a clear link between worry and "self-reported mental health impacts" was also determined: "Among those who say they are either 'very worried' or 'somewhat worried' they or a family member will get sick from coronavirus, six in ten (61%) say worry or stress has had a negative impact on their mental health."[24]

The prevalence of stress and other mental health challenges due to the pandemic is an ongoing global issue, and there has been speculation about how architecture could respond to this issue. In a May 2020 interview, Glasgow architecture professor Ashraf Salama asserted that "environmental psychology and environment-behavior studies will be more important for designers to address."[25] He also discussed the growing interest in biophilic design and its potential to "become a greater part of the discourse in architecture" due to the rising "preference for proximity to nature" for stress relief.[26]

Psychology of Architecture: Appeal to Evolutionary Roots and Other Aspects of Design

When considering the issues of stress and overstimulation as prominent aspects of modern life, especially in urban conditions and during the COVID-19 pandemic, the psychological effects of architecture and design become even more relevant. Buildings that cause us to feel pleasure are those that "incorporate the architectural elements that our brain recognizes as having similar characteristics to those locations that helped our human ancestors to survive."[27]

[23] Keamey et al., "Mental Health Impact."
[24] Keamey et al., "Mental Health Impact."
[25] Michael J. Crosbie, "How might the COVID-19 Change Architectural and Urban Design." *Common Edge*, CommonEdge, 2020, https://commonedge.org/how-might-the-covid-19-pandemic-change-architecture-and-urban-design/
[26] Crosbie, "COVID-19."
[27] Ricci, "Psychological Impact," 10.

For example, people are drawn to patterns in architecture because they represent organization and stability. When prehistoric humans were able to make predictions based on a pattern recognition, their chances of survival increased.[28] So, our brains are wired to associate architecture that incorporates patterns or rhythm with survival, security, and safety, and these buildings have positive psychological effects on us.[29]

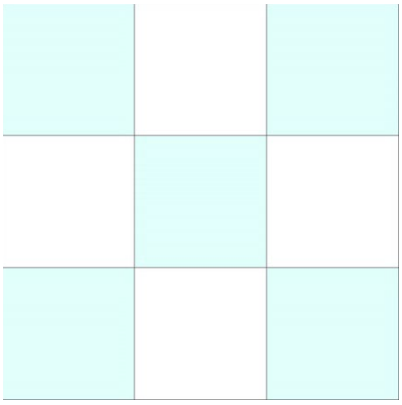

Figure 1: The Nine Square pattern. (Image by Nadia Bove, Nine Patch*, October 30, 2020, "Geometric Patchwork," https://bottegatte.com/il-patchwork-geometrico/)*

A particular pattern, known as the Nine Square due to its 3x3 grid (Fig. 1), is popular in architecture and has a positive psychological impact because of its "similarity to the structure of the human face…facial recognition is one of the paramount survival adaptations of the human race."[30] Also, when our brains recognize "visual similarities to nature" in architecture or when architecture allows us to be in contact with nature, the psychological impacts are beneficial.[31] Richard Neutra was particularly interested in the psychological impact of architecture on its occupants. He theorized that good design was essential to survival, and poor design was detrimental to one's health. For example, Neutra believed that "humans are naturally driven to return to neonatal conditions" and "instinctively desire to be in a safe, protected environment that

[28] Ricci, "Psychological Impact," 11.
[29] Ricci, "Psychological Impact," 12.
[30] Ricci, "Psychological Impact," 19.
[31] Ricci, "Psychological Impact," 33.

mimics the conditions of the mother's womb."[32] This project categorizes design attributes that influence well-being and sensory experience into formal design elements and perceptual, experiential aspects, respectively.

Shape

One aspect of architecture that affects our spatial experience and well-being is shape. A 1935 psychology study concluded that "curves are serene, graceful, and tender-sentimental, [while] angles are robust, vigorous, and somewhat more dignified."[33] Further, rectilinear shapes are viewed as active and efficient, while curved shapes create a more relaxed space.[34] Participants in a 2012 study about shape and emotional responses to interior environments rated curvilinear shapes as much more pleasurable than rectilinear ones. The study concluded that the curvilinear environments "elicited higher amounts of pleasant-unarousing emotions (such as feeling relaxed, peaceful, and calm) than the rectilinear settings."[35] Recently, cognitive neuroscience has illustrated that "we have an innate preference for visual curvature, be it in internal spaces, or for the furniture that is found within the space."[36] Another study determined that we perceive curved interior spaces as more beautiful than rectilinear ones. This is possibly

[32]Lauren Delbridge, "Richard Neutra: With Design in Mind," *Discoveries About Design*, WordPress, 2012, https://blogs.lt.vt.edu/architectureblogdelbridge/class-studies/writing-sample/richard-neutra-with-design-in-mind/

[33] Kate Hevner, "Experimental Studies of the Affective Value of Colors and Lines," *Journal of Applied Psychology* 19, no. 4 (1935).

[34]Sally Augustin, *Place Advantage: Applied Psychology for Interior Architecture* (New Jersey: John Wiley & Sons, Inc., 2009), 56.

[35]Sibel S. Dazkir and Marilyn Read, "Furniture Forms and their Influence on Our Emotional Responses Toward Interior Environments," *Environment and Behavior* 44, no. 5 (September 2012).

[36]Charles Spence, "Sense of Place: Architectural Design for the Multisensory Mind," *Cognitive Research: Principles and Implications* 5, no. 46 (2020): 56.

because curved forms appear more often in nature and "thus feel inherently more natural."[37] Also, shapes that are symmetrical "are more relaxing than asymmetrical ones."[38]

Color

Color also has a profound impact on how we experience spaces, as it strongly influences our feelings and emotions.[39] For example, cool colors like blue and green create restful, quiet spaces that appear more spacious, and warm colors like red and yellow increase stimulation and activity and make spaces appear smaller. A 1998 study found that "people exposed to red and yellow colors reported higher levels of anxiety than did people exposed to cool blue and green colors."[40] Colors that are more saturated are energizing, while colors that are not very saturated are calming.[41] Multiple cool colors in a space create a particularly calming effect.[42] According to a 2004 study of college students, green received the highest number of positive emotional responses (95.9%) due to its associations with nature, forests, and trees. Most of the responses to the green color illustrated emotions like relaxation, comfort, calmness, and happiness. Yellow came in second (93.9%) because it was associated with the sun and summertime. Yellow was generally viewed as energetic and lively, and it evoked happiness and excitement. Blue received the third highest number of positive emotional responses (79.6%) due to its associations with water, the sky, and the ocean. It elicited feelings of calmness, relaxation, peace, and happiness.[43]

Out of the achromatic colors—white, black, and grey—white attained the most positive emotional responses (61.2%) because it was associated with purity, cleanliness, and simplicity.

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[37]Alexander Coburn et al., "Psychological and Neural Responses to Architectural Interiors," *Cortex* 126 (May 2020): 224.
[38]Augustin, *Place Advantage*, 57.
[39]Naz Kaya and Helen H. Epps, "Relationship between Color and Emotion: A Study of College Students," *College Student Journal* 38, no. 3 (2004): 396.
[40]Kaya and Epps, "Color and Emotion," 397.
[41]Augustin, *Place Advantage*, 49.
[42]Augustin, Place Advantage, 50.
[43]Kaya and Epps, "Color and Emotion," 399.

White was viewed as positive and was also associated with peace, innocence, and hope.[44] This study also concluded that "color-related emotion is highly dependent on personal preference and one's past experience with that particular color."[45] Furthermore, green light promotes "the creation of growth hormones and strengthens muscles, bones, and other tissues."[46] Exposure to green can also benefit the immune system. Similarly, blue promotes calmness, lowers high blood pressure, and is often used in light therapy. Additionally, exposure to purple can moderate mental and emotional stress.[47]

Light

Light in architecture and interior spaces also influences psychological well-being: "Low lighting is used…in order to induce relaxation and evoke a sense of protection and hospitality" while bright lighting is used more often in workspaces or competitive spaces because it makes people more productive.[48] Increasing the amount of natural light in a space increases well-being, productivity, mood, and energy. Blue light increases alertness, while warmer-toned light promotes relaxation, comfort, and trust.[49] Designed interior spaces that are perceived as "warm" make people feel calmer, more relaxed, and more secure.[50] These ideas align with a 2010 study on cultural preferences in hotel guestroom lighting design: most of the study participants

[44]Kaya and Epps, "Color and Emotion," 399.
[45]Kaya and Epps, "Color and Emotion," 401.
[46]"The Psychological Impact of Light and Color," *TCP*, TCP, 2017, https://www.tcpi.com/psychological-impact-light-color/
[47]TCP, "Light and Color."
[48]Rosella Tomassoni et al., "Psychology of Light: How Light Influences the Health and Psyche," *Psychology* 6 (2015): 1219.
[49]Vivian Giang, "How Lighting Affects the Productivity of Your Workers," *UNC Kenan-Flagler Business School*, University of North Carolina at Chapel Hill, 2020, https://onlinemba.unc.edu/news/how-lighting-affects-productivity/
[50]Genevieve Spear, "The Effects of Lighting Design on Mood, Attention, and Stress," (Bachelor of Arts Thesis, Reed College, 2018), 3.

preferred warm and dim lighting.[51] Spaces with overhead lighting that is warm-toned and dim, in addition to some lighting around the perimeter of the room, promotes relaxation, privacy, and intimacy. Therefore, non-uniform lighting is best to use in meditative spaces.[52]

Texture

Texture also plays a role in our sensory experience of architecture. Matte surfaces make us feel more relaxed, while shiny surfaces make us feel more energized.[53] Touching smooth textures calms us, while touching rough textures excites us. The number of different textures in a space also affect our perception of the space: "A space with fewer variations in textures is more soothing, while a space with more variation in textures is more energizing."[54] Wood is a material texture that has been shown to have psychological benefits because it is natural. A 2007 study found that people "have clearly positive attitudes toward wood" and "feel good when they are surrounded by wood."[55] A 2006 study observed that "tactile contact with wood, when compared with artificial materials, caused no psychophysiological stress responses."[56] When asked to evaluate different materials in another 2006 study, participants rated wood "higher than the other materials in terms of being perceived as 'warm,' 'natural,' 'homey,' 'relaxing,' and 'inviting.'"[57]

Therefore, research shows that people find curved spaces more relaxing than rectilinear ones, and spaces with desaturated and cool colors are perceived as more calming than spaces with saturated and warm colors. Research has also shown that dim, warm, or natural light is

[51]Nam-Kyu Park et al., "Cultural Preferences in Hotel Guestroom Lighting Design," *Journal of Interior Design* 36, no. 1 (2010): 28.
[52]TCP, "Light and Color."
[53]Augustin, Place Advantage, 56.
[54]Augustin, Place Advantage, 65.
[55]Nyrud and Bringslimark, "Interior Wood Use," 208.
[56]Nyrud and Bringslimark, "Interior Wood Use," 207.
[57]Nyrud and Bringslimark, "Interior Wood Use," 210.

more relaxing than bright, cool, or artificial light, and smooth or matte textures are more calming than rough or shiny textures, respectively.

Complexity

Also, perceptual qualities can affect our sensory experience. In particular, the perceived complexity level of a space can affect our well-being. Complexity is "one of the most important factors related to aesthetic preferences" and people generally prefer spaces "that have a moderate degree of complexity, i.e., it should not be too low or high in diversity or richness of elements."[58] Although people are drawn to patterns in architecture, too much repetition without some complexity is unpleasant and "dull[s] the senses."[59] Complexity appeals to us because as humans, we seek cognitive stimulation.[60] Spaces with "moderate complexity and high order" are pleasing, while those with "too much visual complexity and too little order" are repelling.[61] Interiors with too much visual chaos cause anxiety.[62] Spaces with "patterned complexity" can "function as arenas of serenity, allowing our minds to freely wander, replenishing our depleted attentional and other internal resources."[63] Further, a 1993 study of preference in interior environments concluded that "complexity was a preferred environmental attribute" and "the lack of complexity or richness was the most frequently mentioned characteristic of nonpreferred scenes."[64] Another 1993 study found a strong positive correlation between complexity and

[58]Nyrud and Bringslimark, "Interior Wood Use," 211
[59]Sarah Williams Goldhagen, *Welcome to Your World: How the Built Environment Shapes Our Lives* (New York: Harper Collins Publishers, 2017), 233.
[60]Goldhagen, *Welcome to Your World*, 234.
[61]Augustin, *Place Advantage*, 59.
[62]Augustin, *Place Advantage*, 58.
[63]Goldhagen, *Welcome to Your World*, 236.
[64]Suzanne C. Scott, "Visual Attributes Related to Preference in Interior Environments," *Journal of Interior Design* 18, no. 1-2 (1993b): 14.

preference and illustrated that "people are likely to prefer interiors that offer more rather than less complexity."[65]

Theory of Affordances and its Applications to Architectural Design

The theory of affordances, developed by psychologist James Gibson in the 1960s, "describes how animals perceive their environment."[66] The theory contradicted the previously held view that the environment is meaningless. The environment had been thought of as mechanized, and theorists had "made a distinction between primary and secondary qualities."[67] Primary qualities were properties of the environment that existed "independent of the observer," and secondary qualities were those like meaning and color that were said to exist in the mind but not the environment. However, Gibson's theory of affordances argued that the environment is meaningful and includes affordances, which give it meaning. The theory asserts that "the animal's environment consists of opportunities for action" and the environment is not "a collection of causes" but rather "a manifold of action possibilities."[68] The possibilities for action are determined by the relationship between the observer and their environment.[69] For an action possibility to exist, "an affordance needs to be perceived."[70] Further, affordances of the environment are permanent; they "do not change as the need of the observer changes."[71] Gibson stated that "something that looks good today may look bad tomorrow but what it actually offers

[65]Suzanne C. Scott, "Complexity and Mystery as Predictors of Interior Environments," *Journal of Interior Design* 19, no. 1 (1993a): 31.
[66]Maier and Fadel, "Approach," 395.
[67] Withagen et al., "Affordances," 251.
[68] Withagen et al., "Affordances," 251.
[69] Withagen et al., "Affordances," 251.
[70] Fiona Young and Benjamin Cleveland, "Affordances, Architecture, and the Action Possibilities of Learning Environments: A Critical Review of the Literature and Future Directions," *Buildings* 12, no. 1 (2022).
[71] Withagen et al., "Affordances," 251.

the observer will be the same."[72] Therefore, Gibson's affordance theory states that the environment is perceived in terms of affordances: opportunities for action that are in the environment and do not depend on the observer's mind. Since affordances are opportunities for action, "they do not cause behavior, but simply make it possible."[73] The observer's behavior is not caused by the properties of the environment, but it is the way in which the observer can "utilize the affordances in their environment."[74] So, the information is not imposed, but obtained by an active observer.[75] Additional theorists have proposed that observers' experiences, social settings, and cultures determine their "ability and intentions toward using affordances."[76]

The concept of affordances can lead to a greater understanding of the interaction between people and the built environment, "especially with regard to the form, function, and meaning of architectural elements."[77] Affordance theory has been influential in Environment and Behavior research, which examines "the relations between people and their surroundings" and aims to discover means by which environment and behavior are linked.[78] The concept of affordances can contribute to this work, since affordances "link the structure of the environment with the capabilities of human users to determine what behaviors are possible and even likely."[79] Person-environment theories within the behavioral sciences view person and environment as fluid, "one changing as the other changes, with cause and effect being difficult to separate."[80] The theory of affordances can aid our understanding of this relationship: "The person-environment relationship is then viewed as a unified interaction, from which individual components of the environment

[72] Withagen et al., "Affordances," 251.
[73] Withagen et al., "Affordances," 251.
[74] Withagen et al., "Affordances," 252.
[75] Withagen et al., "Affordances," 252.
[76] Young and Cleveland, "Action Possibilities."
[77] Maier and Fadel, "Approach," 394.
[78] Maier and Fadel, "Approach," 401.
[79] Maier and Fadel, "Approach," 401.
[80] Maier and Fadel, "Approach," 402.

and behavior experience cannot be separated."[81] The awareness of the observer and the experiential character of the place are considered when viewing this relationship. This view highlights the idea that "affordances depend on both the artifact (i.e., environment) and user (i.e., person) and do not exist in isolation from the other."[82] Meaning that stems from the forms of architectural elements and the past experiences of the person can be regarded as a separate affordance.[83] Meaning in architecture has an important role in connecting people with places, so it can enable a greater understanding of the affordances in a particular context by helping to explain the connections between user and environment.[84] Therefore, "the concept of affordance provides an alternate way of viewing the design of environments, emphasizing the complementarity of the relationship between environments and their users."[85] Affordance theory can provide architectural design with a "rigorous theoretical basis" because it connects people with the built environment and "explains why and how users behave the way they do."[86]

Project Development Plan

The method of data collection for this capstone was informed by previous studies. Four research studies served as inspiration for the method of the project.

In the first study researched, a 2020 study of psychological responses to architectural interiors was conducted with 800 participants who "collectively rated 200 images of architectural interiors on sixteen aesthetic rating scales."[87] These rating scales included Complexity, Beauty,

[81] Maier and Fadel, "Approach," 402.
[82] Maier and Fadel, "Approach," 402.
[83] Maier and Fadel, "Approach," 402.
[84] Maier and Fadel, "Approach," 403.
[85] Maier and Fadel, "Approach," 404.
[86] Maier and Fadel, "Approach," 410.
[87] Coburn et al., "Psychological and Neural Responses," 222.

Naturalness, Comfort, Relaxation, and Uplift. The rating prompts included "This room looks…" and "This room makes me feel…" and used a "7-point sliding semantic differential scale."[88] Low anchors of the rating scales included Artificial, Uncomfortable, and Stressed, while high anchors included Natural, Comfortable, and Relaxed, respectively. Participants filled out a "brief demographic questionnaire" after completing the study.[89]

A study in 2019 explored the psychological responses to "natural patterns in architecture."[90] Researchers recruited 100 participants to collectively rate 240 images, 120 of architectural interiors and 120 of architectural exteriors "on their perceived level of naturalness". The rating prompt and scale used was like those used in the 2020 study, as participants were shown the images "in a randomized order and were asked to rate each image in response to the prompt, 'How artificial or natural does this building interior [or exterior] look to you?'". A 7-point Likert scale presented the answer choices; the low anchor (1) was Very Artificial, and the high anchor (7) was Very Natural.[91]

In a third study on psychological responses to natural landscapes and building exteriors, 275 participants collectively rated 128 images, 64 of landscapes and 64 of exterior architecture. Participants rated each image on the same sixteen aesthetic criteria that had previously been used in the 2020 study; the same 7-point rating scale, low and high anchors, and rating prompts were also used. After rating all images, participants filled out a demographic questionnaire.[92]

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[88] Coburn et al., "Psychological and Neural Responses," 223.
[89] Coburn et al., "Psychological and Neural Responses," 223.
[90] Alexander Coburn et al., "Psychological Responses to Natural Patterns in Architecture," *Journal of Environmental Psychology* 62 (2019): 133.
[91] Coburn et al., "Natural Patterns," 138.
[92] Adam B. Weinberger et al., "Psychological Responses to Buildings and Natural Landscapes," *Journal of Environmental Psychology* 77 (October 2021).

A final study examined the impact of a "multisensory biophilic environment"[93] on well-being. Participants completed surveys "to measure feelings of stress, environmental satisfaction, … mood, and connectedness to nature."[94] During one of the experiments, "images transitioned every 2 min[utes] to maximize the potential for participants to view each of the included digital nature scenes."[95]

After researching these four studies, the data collection method for this capstone project was determined. This method was pilot tested with two University of Arkansas students for timing purposes and general feedback. Both participants came to the designated location used for the actual data collection. One participant was an architecture student; the other was not. The pilot testers completed a questionnaire that measured their perceived level of stress. Then, they viewed ten images of designed interior spaces while completing rating scales for each image. Since the pilot test was not anonymous, data from it was not used in the final study, and the pilot testers were not entered into the gift card drawing.

Both participants were timed for the duration of the procedure as well as specifically when they were viewing the images. Based on feedback, the number of images was reduced from ten to eight. The total time needed for the procedure was estimated at 20 minutes.

Methods/Process Description

Sample

University of Arkansas students were recruited to participate in the study. This included a group of students recruited from the Fay Jones School of Architecture and Design (n = 62) and a

[93] Sara Aristizabal et al., "Biophilic Office Design: Exploring the Impact of a Multisensory Approach to Human Well-Being." *Journal of Environmental Psychology* 77 (October 2021).
[94] Aristizabal et al., "Biophilic Office Design."
[95] Aristizabal et al., "Biophilic Office Design."

group of students recruited from other schools within the university (n = 14). Recruitment methods included advertising the project in the Arkansas Newswire, placing flyers throughout the School of Architecture and Design and other adjacent buildings on the University of Arkansas campus, promoting the project on social media via my personal accounts, and having the director of student services send an email to the architecture school advertising the project. Each participant was given the opportunity to enter themselves into a drawing with the chance of winning one of five $25 Amazon gift cards. The project was approved by the IRB of the University of Arkansas, and informed consent was obtained from all participants.

Figure 2: Image of data collection space.

Site

The data was collected in person at the media center in Vol Walker Hall, a publicly accessible space on the University of Arkansas campus. The location was open for data collection for the study over a three-day period for a total of fifteen hours. Participants scheduled their times to participate through the scheduling platform Calendly. Time blocks of 30 minutes were allotted for a maximum of eight participants for each sitting.

Instruments

The purpose of this capstone project is to evaluate how architecture, specifically spaces of meditation and retreat, can moderate the effects of stress and overstimulation on people. Therefore, the data collection process included the completion of a questionnaire to measure stress levels. The questionnaire selected for use in this project is called the Perceived Stress Scale.[96] This survey is "a measure of the degree to which situations in one's life are appraised as stressful" and "also includes a number of direct queries about current levels of experienced stress."[97] The Perceived Stress Scale asks about feelings and thoughts during the last month; each question asks how often the respondent felt a certain way. Scores are calculated by "reversing responses (e.g. 0 = 4, 1 = 3, 2 = 2, 3 = 1, & 4 = 0) to the four positively stated items (items 4, 5, 7, & 8) and then summing across all scale items."[98] According to the stress scale, stress scores are then identified as low, medium, or high; a low stress score is between 0-13, a moderate stress score is between 14-26, and a high stress score is between 27-40.[99]

Images

Since the data collection process focused on designed interior spaces of meditation and retreat and their impact on stress, images of various meditative spaces were used in the study. Following the pilot test, the images were reviewed, and the final eight images used in the study were selected for diversity based on characteristics explored in the literature review. These images were of eight different architectural projects designed for meditation and retreat.

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[96] Sheldon Cohen, "Perceived Stress Scale," *American Sociological Association*, 1983, https://www.sprc.org/system/files/private/event-training/Penn%20College%20-%20Perceived%20Stress%20Scale.pdf

[97] Cohen, "Perceived Stress Scale."

[98] Cohen, "Perceived Stress Scale."

[99] Cohen, "Perceived Stress Scale."

The Therme Vals, Vals, Switzerland

Designed by Peter Zumthor and completed in 1996, this is a complex of spas and thermal baths designed to provide a "complete sensory experience."[100] The project was the "first material contribution" to the Neue Sinnlichkelt (New Sensuousness) movement in architecture: a movement beginning around 1990 aimed at "creating buildings that appeal to a full sensory and bodily perception."[101] The Therme Vals presents a clean-cut architecture which emphasizes materiality and importantly "an architecture that appeal[s] to and [is] a product of the senses."[102] In the thermal baths, Zumthor "indulges in the building's sensuality and physicality, and in its relation with the human body."[103]

Figure 3: The image selected to represent the Therme Vals in the study. (Photo by Global Image Creation, 7132 Thermal Baths 7*, "High Resolution Images," https://7132.com/en/corporate/press/high-resolution-images)*

The image above (Fig. 3) was selected to represent the Therme Vals in the study due to its depiction of the project's light quality, material texture and color, and connection to nature. The image shows natural light, the cool blue texture of the Vals quartzite, and a view to the

[100] Mina Dreki, "Architecture and Phenomenology: Zumthor's Therme Vals Spa Examined with a Phenomenological Approach," (Dissertation, The Greek Open University), 3.
[101] Erik Wegerhoff, "Neue Sinnlichkelt: Postcritical Issues Regarding an Architecture of Sensuousness," *Future Anterior: Journal of Historic Preservation, History, Theory, and Criticism* 13, no. 2 (Winter 2016): 121.
[102] Wegerhoff, "Neue Sinnlichkelt," 121.
[103] Wegerhoff, "Neue Sinnlichkelt," 122.

exterior showing trees and grass. The image also displays how the water interacts with the light and the quartzite material.

Windhover Contemplative Center, Stanford, California

Designed by Aidlin Darling Design and completed in 2014, the center is a spiritual retreat on the Stanford University campus to promote and inspire personal renewal.[104] The architects created a connection between the building and nature to help students and faculty retreat from the stress of the campus and refresh. The center uses tall wooden beams and glass to mimic the forms of the nearby trees and allow natural light to penetrate. The irregular pattern of these elements brings the language of materiality and verticality to the interior.[105] Corten steel, rammed earth walls, and water unify art, architecture, and landscape and heighten the user's sensory experience.[106]

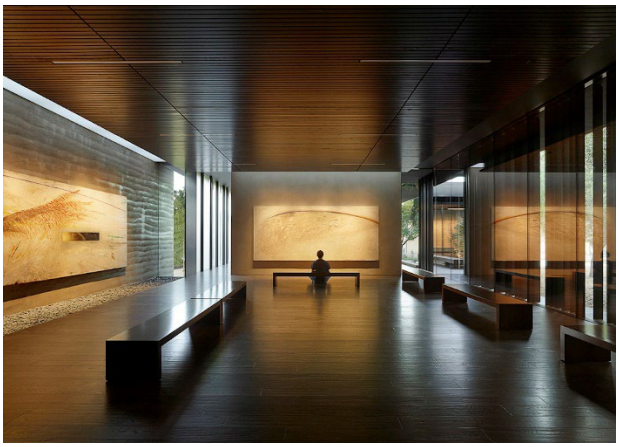

Figure 4: The image selected to represent the Windhover Contemplative Center in the study. (Photo by Matthew Milman Photography, March 18, 2015, "Windhover Contemplative Center / Aidlin Darling Design," https://www.archdaily.com/608268/windhover-contemplative-center-aidlin-darlin-design)

[104] "Windhover Contemplative Center," *Stanford Office for Religious and Spiritual Life*, Stanford University, 2022, https://orsl.stanford.edu/who-we-are/memorial-church-companion-spaces/windhover-contemplative-center
[105] Mary C. Overholt, "Aidlin Darling Design Brings the Outdoors to the Inside of the Windhover Contemplative Center," *University Wire* (November 2014).
[106] "The Contemplation Center," *Stanford Office for Religious and Spiritual Life*, Stanford University, 2022, https://orsl.stanford.edu/who-we-are/memorial-church-companion-spaces/windhover-contemplative-center/contemplation-center

The image above (Fig. 4) was selected to represent the Windhover Contemplative Center in the study due to its depiction of the project's light quality, rectilinear shape, material color and texture, and views to the exterior. The lighting is dim, but natural daylight penetrates through glass and openings. The colors of the space in the image are warm browns, yellows, and oranges. Some of the surfaces are highly textured, while others are shiny, and the light in the image interacts with each in various ways. The image also depicts the rectangular quality of the space, as it appears much wider than it is high. The person sitting in the center and exterior views on each side help balance the image.

Immersive Space Series, San Francisco, California

This is an ongoing research project since 2017 by Office of Things. The series explores how meditation spaces within workspaces can benefit employees. This type of Immersive Space, called "Coves," is installed in Google and YouTube offices in San Francisco, California.[107] These spaces provide an intense immersive experience for workplace retreat through light, color, and sound.[108] Each space has three components: The Entry, The Ground, and The Sky. The Entry is a narrow walkway that shields the user from the outside world; The Ground is made of upholstered walls, benches, and cushions; and The Sky is multiple illuminated ceiling panels that glow with color.[109]

[107] Natasha Levy, "Meditation Chambers by Office of Things Wash Workers in Colourful Light," *Dezeen*, Dezeen, 2020, https://www.dezeen.com/2020/12/13/meditation-room-interiors-offices/
[108] "Immersive Space Series: Coves," *Office of Things*, Office of Things, 2022, https://oo-t.co/IMMERSIVE-SPACE-SERIES-COVES-Bay-Area-California
[109] Levy, "Meditation Chambers."

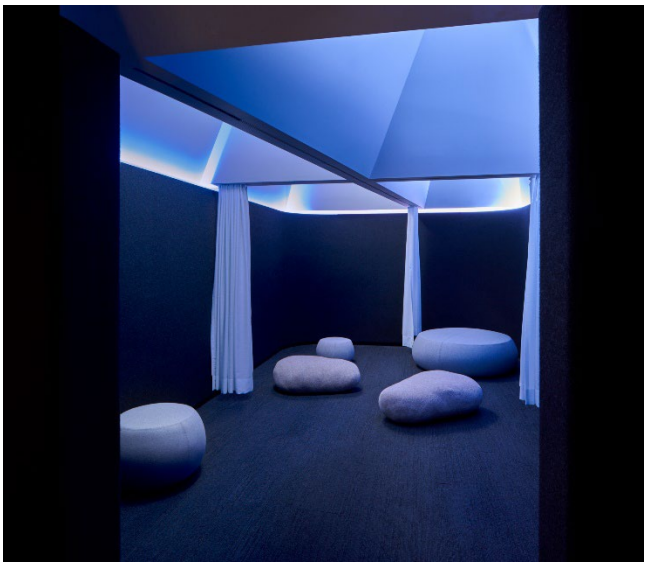

Figure 5: The image selected to represent the Immersive Space Series in the study. (Photo by Joanna Arnold, Impart Photography, "Immersive Space Series: Coves," https://oo-t.co/IMMERSIVE-SPACE-SERIES-COVES-Bay-Area-California)

The image above (Fig. 5) was selected to represent the Immersive Space Series in the study due to its depiction of the space's light quality, blue color, and texture. The lighting is dim, artificial, and comes directly from a small skylight and coves at the ceiling. The shape of the space is somewhat amorphous, and the space is different tones of blue. The ceiling elements in the space have a smooth texture, while the curtains, floor, walls, and cushions have a slightly rougher fabric texture.

The Retreat, The Londoner Hotel, London, England

Designed by Yabu Pushelberg and completed in 2021, this wellness spa is located deep underground. It is a space where hotel guests can escape from the stress of the city. Artificial skylights in the pool area mimic diffused sunlight, and materials are juxtaposed to create a unique experience. The space utilizes a neutral warm color palette that complements the spa's comforting atmosphere.[110]

[110] Nicholas Boever, "Yabu Pushelberg Carves Out Secluded Wellness Spa Beneeath London Hotel," *DesignWell,* Emerald X, LLC, 2022, https://designwell365.com/news-features/design-news/yabu-pushelberg-carves-out-secluded-wellness-spa-beneath-london-hotel/

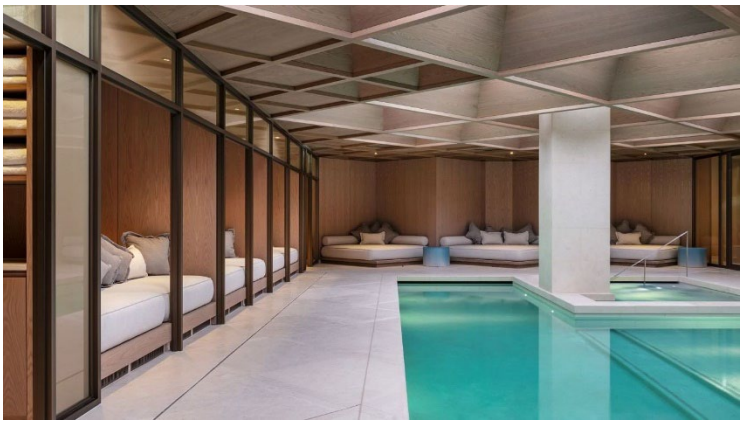

Figure 6: The image selected to represent The Retreat in the study. (Photo by Andrea Beasley, Swimming Pool*, February 9, 2022, "The Londoner Is a Truly Capital Hotel," https://squaremile.com/travel/londoner-hotel-review/)*

The image above (Fig. 6) was selected to represent The Retreat in the study due to its depiction of the space's light quality, colors, textures, and shape. The light is artificial, bright, and diffused. The colors of the space are warm browns on the walls and ceiling and white and blue on the floor and in the pool, which provides contrast. Textures of the space include wood, stone, fabric, and water. The arrangement of adjacent spaces and the design of the ceiling provide pattern and rhythm within the rectilinear shape of the space.

The Well, New York, New York

This wellness center provides health and wellness services for its guests in a healthy and exquisite environment. The center was designed by Rose Ink Workshop and completed in 2019. The street level is open and social, while the lower level is dedicated to private rejuvenation. An actual well is at the heart of the space, which inspired the curved walls in the lower level. The dome-shaped meditation room was designed to be an "oasis of calm" within the city.[111]

[111] April Long, "The Well, the Latest Health Hot Spot, Opens in New York City." *Town and Country*, Hearst Magazine Media, 2022, https://www.townandcountrymag.com/style/beauty-products/a29190766/the-well-opens-in-new-york-city/

Figure 7: The image selected to represent The Well in the study. (Photo by The Well, October 11, 2019, "Rose Ink Workshop Designs Membership Club for Wellness in New York City," https://www.dezeen.com/2019/10/11/rose-ink-workshop-membership-club-wellness-new-york-city/)

The image above (Fig. 7) was selected to represent The Well due to its depiction of the meditation room's curved shape, lighting quality, color, and material texture. The lighting is diffused and artificial. The ceiling of the space is yellow, while the rest of the space has cool blue and grey colors. The texture of the walls and ceiling is smooth, while the texture of the floor is carpeted and rough.

Inscape Meditation Studio in New York, New York

This meditation studio was designed by Archi-Tectonics and completed in 2016. The meditation studio includes lounge and retail space to provide a "gradual transition from the hustling and bustling NY streets" to the meditation spaces.[112] The Dome is "a highly engineered space with an immersive light and sound environment" that changes depending on the meditation chosen.[113] The oculus symbolizes eternal space and mind expansion, while the lower ring represents a horizon that "induces a calm reflective state of mind."[114] The design aims to create "a moment of respite in a busy city" where "one can leave the world outside and focus on

[112] Archi-Tectonics, "Inscape Meditation Studio," *Archello*, Archello, 2022, https://archello.com/project/inscape-meditation-studio
[113] Archi-Tectonics, "Inscape."
[114] Archi-Tectonics, "Inscape."

oneself."[115] The dome is made of bamboo, and it is covered with a white sail and an outside shell.[116]

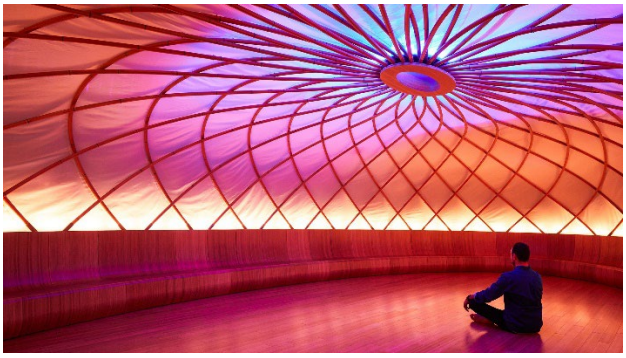

Figure 8: The image selected to represent Inscape Meditation Studio in the study. (Photo by Frederick Charles, The Large Meditation Room at Inscape*, November 23, 2016, "The Perfect Meditation Space is in the Middle of New York City," https://www.architecturaldigest.com/story/inscape-perfect-meditation-space-new-york-city-intermix)*

The image above (Fig. 8) was selected to represent Inscape Meditation Studio in the study due to its depiction of the space's domed shape, lighting quality, and texture. The light is bright, direct, artificial, and colorful, with tones of red, orange, purple, and blue. The floor texture is shiny wood, while the domed area shows the pattern formed by the bamboo elements as well as the fabric texture of the sail.

AYC, Santiago, Chile

A yoga studio designed by DX Arquitectos, the studio was completed in 2014. The studio was built entirely out of timber, and "the exposed structure also relates to the structure of the human body, and an understanding of yoga as the practice of 'body art.'"[117] Windows at high and low levels "avoid direct sunlight and allow for natural cross-ventilation" while "providing eye-level views of surrounding treetops."[118] The goal was to create a spiritual atmosphere.[119]

[115] Archi-Tectonics, "Inscape."
[116] Archi-Tectonics, "Inscape."
[117] Luke Tebbutt, "DX Arquitectos Extends Yoga Teacher's House with a Blackened Timber Studio on Top," *Dezeen*, Dezeen, 2015, https://www.dezeen.com/2015/11/28/dx-arquitectos-ashtanga-yoga-chile-teachers-house-extension-blackened-timber-studio-santiago/
[118] Tebbutt, "DX Arquitectos."
[119] Tebbutt, "DX Arquitectos."

Figure 9: The image selected to represent AYC in the study. (Photo by Pablo Blanco, November 28, 2015, "DX Arquitectos Extends Yoga Teacher's House with a Blackened Timber Studio on Top," https://www.dezeen.com/2015/11/28/dx-arquitectos-ashtanga-yoga-chile-teachers-house-extension-blackened-timber-studio-santiago/)

The image above (Fig. 9) was selected to represent AYC in the study due to its depiction of the space's shape, light quality, color, and material texture. The image shows natural light and how it interacts with the slightly rough and shiny texture of the wood. The space has a rectilinear shape and warm colors.

Meditation Space for Creation, Beijing, China

Designed by Jun Murata and completed in 2019, this space is an artist's residence and gallery that "invites guests inside a meditative space of light and reflections."[120] The space is narrow and linear, with openings on both ends that provide exterior views of nature: "its pure white color, in combination with reflective materials, natural light, and the surrounding greenery compose a serene environment that helps the human mind unwind."[121] A vertical beam of light and a slit in the wall "create a game of light and shadows."[122]

[120] Sofia Lekka Angelopoulo, "Jun Murata Turns Shipping Container into Meditative Gallery and Artist's Residence in Beijing, *DesignBoom*, DesignBoom, 2020, https://www.designboom.com/architecture/jun-murata-shipping-container-gallery-artist-residence-beijing-11-15-2020/

[121] Angelopoulo, "Shipping Container."

[122] Angelopoulo, "Shipping Container."

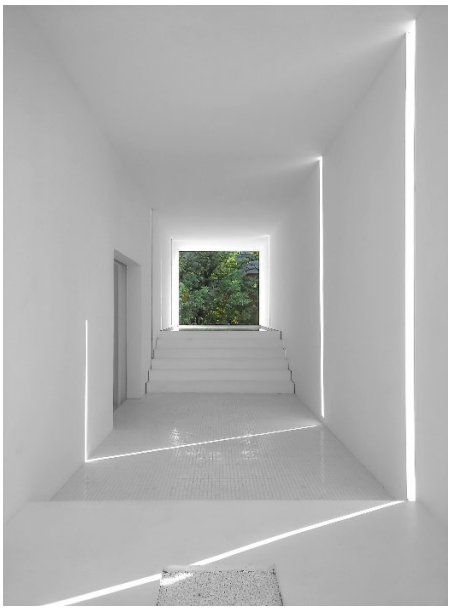

Figure 10: The image selected to represent the Meditation Space for Creation in the study. (Photo by Jun Murata, March 14, 2020, "Meditation Space for Creation / Jun Murata / JAM," https://www.archdaily.com/935462/meditation-space-for-creation-jam?ad_medium=gallery)

The image above (Fig. 10) was selected to represent the Meditation Space for Creation due to its depiction of the space's shape, light quality, bright white color, and material texture. The space is narrow, tall, and linear, and the camera faces an exterior opening showing trees that connect the space to nature. The space is a bright white color and bright light interacts in different ways with the matte, shiny, smooth, and textured surfaces, becoming both direct and diffused.

During the image selection process, each image was considered with respect to eight variables. The variables were shape, light, color, texture, naturalness, beauty, complexity, and comfort. For this study, color was defined as either warm, cool, or neutral, and desaturated or saturated. Shape was defined as either rectilinear, curvilinear, or amorphic. Light was defined as either bright or dim, either diffused or direct, and either natural or artificial. Texture was defined as either smooth or rough and either matte or shiny. Naturalness was defined as the quality or state of existing in or being caused by nature, not made or caused by humankind. Beauty was

defined as a combination of qualities, such as shape or color, that please the aesthetic senses, especially the sight. Complexity was defined as the state or quality of being intricate or complicated. Comfort was defined as something that provides physical ease and relaxation and alleviates stress and fear.

	Shape	**Color**	**Texture**	**Light**	**Material**	**View**
Therme Vals	Rectilinear[3]	Cool Blue/Green[2]	Rough[3]	Natural, indirect	Natural [1]	Nature[2]
Windhover	Rectilinear[3]	Warm Neutral, desaturated[2]	Smooth[2]	Natural, artificial, indirect	Natural [1]	Nature[2]
Immersive Space	Rectilinear[3]	Cool, fairly saturated[2]	Smooth[2]	Artificial, diffuse	Human Made	No View
The Retreat	Rectilinear[3]	Warm Neutral[2]	Combination, not shiny	Artificial, diffuse	Human Made	No View
The Well	Curved[2]	Cool Neutral[2]	Combination, not shiny	Artificial, diffuse	Combination	No View
Inscape	Curved[2]	Warm, Saturated[2]	Smooth[2]	Artificial, diffuse	Natural [1]	No View
AYC	Rectilinear[3]	Warm neutral[2]	Rough[3]	Natural, indirect	Natural [1]	Nature[2]
Space for Creation	Rectilinear[3]	White[2]	Smooth[2]	Natural, direct	Human Made	Nature[2]

Table 1: Design Attributes Present in Images of Meditative Spaces.

[1] Spaces were categorized as Natural when more than 75% of their materials were clearly derived from nature such as wood or stone.

[2]Positive/pleasing/relaxing/biophilic evaluation in research findings.

[3]Negative/less pleasing/energetic evaluation in research findings.

Procedure

After arriving at the media center at their appointment time and checking in, participants completed an informed consent form. Then, participants were presented with a QR code that took them to a digital form where they entered their name and email address to be entered into the gift card drawing. Participants then filled out an anonymous paper questionnaire that measured their perceived level of stress, including one question addressing the respondent's perceived sensitivity to their physical environment, and three additional demographic questions (gender, year level in college, and major in or out of the School of Architecture and Design). After completing the stress questionnaire, the participants viewed eight images of designed interior spaces while completing rating scales for each image. To avoid order effect, images were reordered in three different sets. Participants used computer monitors to view the images, and images were presented as a timed PowerPoint presentation. Images transitioned every two minutes to give participants adequate time to view and complete the evaluation.

The questions used a 7-point semantic differential scale, and the participants were asked to record their impression of the space for each image using paper surveys. The first four rating prompts asked participants to rate the shape, light, color, and texture of the space shown in the image. The low anchor for the rating scale for these four questions was Stressful, and the high anchor was Calming. The rating prompt for the next three questions was "This room looks…" Low anchors for the rating scales for the next three questions were Artificial, Ugly, and Simple, and high anchors were Natural, Beautiful, and Complex. The rating prompt for the last three questions was "This room makes me feel…" Low anchors for the rating scales for the last three questions were Uncomfortable, Depressed, and Stressed, and high anchors were Comfortable, Uplifted, and Relaxed.

The data was stored on paper and entered electronically into a spreadsheet for analysis. Participants were assured of confidentiality, and there was no identifying information on the paper surveys. The surveys, consent forms, and email forms were stored in separate locations, and no personal information was recorded. The information gathered from the scheduling software (name and email) was also kept in a separate location. The paper surveys with the data were kept in a locked cabinet in a locked office until data collection and analysis was complete and the winners of the gift card drawing received their gift cards. Participants were notified through email if they won the gift card drawing. Then, the data was shredded or otherwise destroyed.

Results and Outcomes

Demographics

The sample consisted of 67.1% (n = 51) females, 31.6% (n = 24) males, and 1.3% (n = 1) non-binary people. The majority of the sample (81.6%, n = 62) were students from the Fay Jones School of Architecture and Design, while 18.4% (n = 14) were students from other schools within the University of Arkansas. 28.9% of the sample (n = 22) were first-year students, 9.2% (n = 7) were second-year students, 25% (n = 19) were third-year students, 14.5% (n = 11) were fourth-year students, 11.8% (n = 9) were fifth-year students, and 10.5% (n = 8) were graduate students.

Stress

Stress scores for all participants ranged from 8 to 35 based on a 0 to 40 scale identified by the Perceived Stress Scale. The average stress score for all participants was 20.72 (n = 76, SD =

5.71). The average stress score for Fay Jones School students was 21.05 (n = 62 , SD = 5.70) and 19.29 (n = 14, SD = 5.78) for non-Fay Jones School students.

Stress Score Severity	Percentage of Participants
Low	11.8% (n = 9)
Medium	71.1% (n = 54)
High	17.1% (n = 13)

Table 2: Percentage of Participants by Stress Score Severity.

Year Level in College	Average Stress Score
First Year	21.73
Second Year	21.71
Third Year	19.84
Fourth Year	21.09
Fifth Year	20.44
Graduate Student	19

Table 3: Average Stress Scores by Year Level in College.

Figure 11: Box and whisker plots of the stress scores.

Therme Vals

For the image of Therme Vals, means and standard deviations were calculated across the four design attributes (Table 4). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on all design attributes.

	Shape	Light	Color	Texture
Overall	M = 5.38 SD = 1.31	M = 6 SD = 1.28	M = 5.91 SD = 1.25	M = 5.45 SD = 1.41
Arch/Design Major	M = 5.47 SD = 1.11	M = 6.1 SD = 1.11	M = 5.98 SD = 1.11	M = 5.48 SD = 1.36
Other Major	M = 5 SD = 1.96	M = 5.57 SD = 1.82	M = 5.57 SD = 1.74	M = 5.29 SD = 1.64

Table 4: Evaluation of Design Attributes for Therme Vals. 1 = Stressful and 7 = Calming.

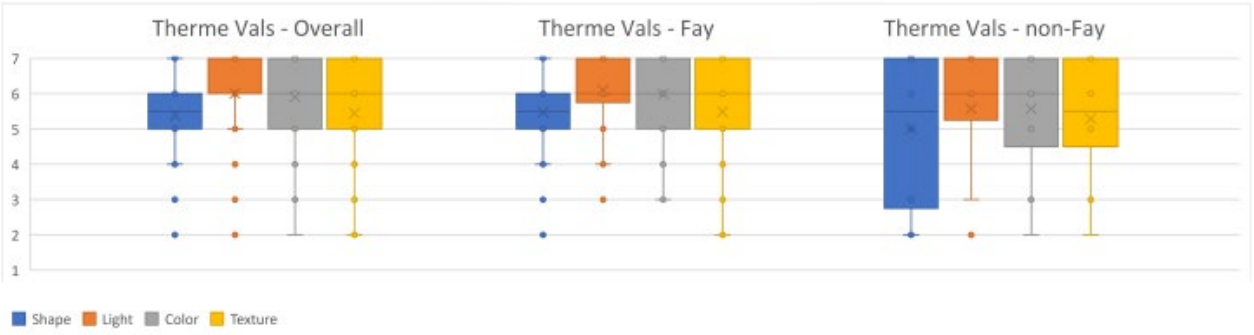

Figure 12: Box and whisker plots of the ratings of the design attributes for the Therme Vals image.

For the image of Therme Vals, means and standard deviations were also calculated across the six perceptual qualities (Table 5). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on all perceptual qualities.

	Naturalness	Beauty	Complexity	Comfort	Uplift	Relaxation
Overall	M = 5 SD = 1.66	M = 5.92 SD = 1.42	M = 3.99 SD = 1.66	M = 5.29 SD = 1.34	M = 5.83 SD = 1.39	M = 5.97 SD = 1.33
Arch/Design Major	M = 5.15 SD = 1.57	M = 6.1 SD = 1.14	M = 3.89 SD = 1.63	M = 5.34 SD = 1.25	M = 5.95 SD = 1.12	M = 6.15 SD = 1.05
Other Major	M = 4.36 SD = 1.95	M = 5.14 SD = 2.18	M = 4.3 SD = 1.79	M = 5.1 SD = 1.73	M = 5.29 SD = 2.2	M = 5.21 SD = 2.04

Table 5: Evaluation of Perceptual Qualities for Therme Vals. 1 = Least and 7 = Most.

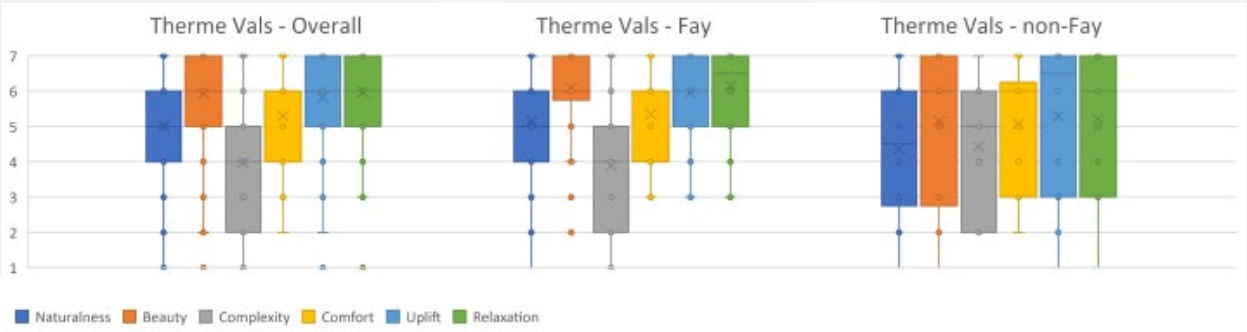

Figure 13: Box and whisker plots of the ratings of the perceptual qualities for the Therme Vals image.

Windhover Contemplative Center

For the image of the Windhover Contemplative Center, means and standard deviations were calculated across the four design attributes (Table 6). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on most design attributes.

	Shape	Light	Color	Texture
Overall	M = 5.29 SD = 1.32	M = 5.68 SD = 1.48	M = 5.43 SD = 1.33	M = 5.45 SD = 1.31
Arch/Design Major	M = 5.37 SD = 1.26	M = 5.87 SD = 1.38	M = 5.6 SD = 1.27	M = 5.52 SD = 1.36
Other Major	M = 4.93 SD = 1.59	M = 4.86 SD = 1.66	M = 4.71 SD = 1.38	M = 5.14 SD = 1.03

Table 6: Evaluation of Design Attributes for Windhover Contemplative Center. 1 = Stressful and 7 = Calming.

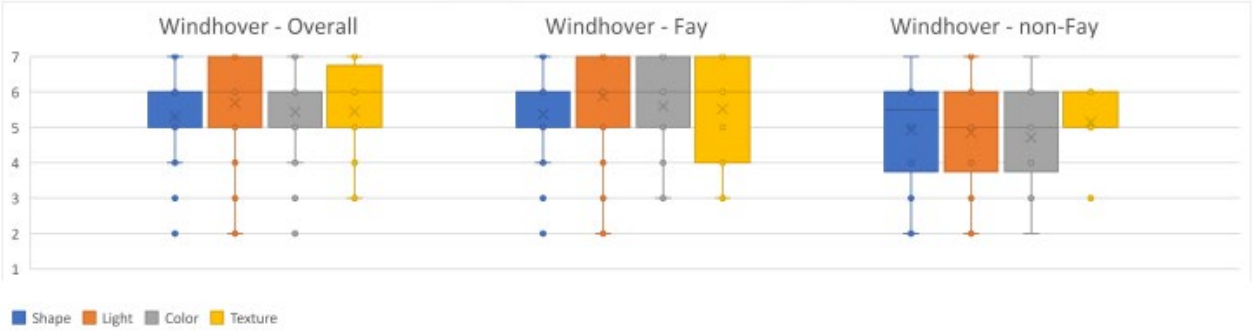

Figure 14: Box and whisker plots of the ratings of the design attributes for the Windhover Contemplative Center image.

For the image of Windhover Contemplative Center, means and standard deviations were also calculated across the six perceptual qualities (Table 7). Box and whisker plots of the means and standard deviations indicate a slightly more dispersed response for the architecture/design students on most perceptual qualities.

	Naturalness	Beauty	Complexity	Comfort	Uplift	Relaxation
Overall	M = 4.3 SD = 1.61	M = 5.51 SD = 1.21	M = 4.16 SD = 1.59	M = 4.18 SD = 1.68	M = 4.62 SD = 1.36	M = 5.41 SD = 1.22
Arch/Design Major	M = 4.37 SD = 1.54	M = 5.63 SD = 1.2	M = 4.21 SD = 1.6	M = 4.23 SD = 1.69	M = 4.69 SD = 1.39	M = 5.53 SD = 1.2
Other Major	M = 4 SD = 1.92	M = 5 SD = 1.11	M = 3.39 SD = 1.59	M = 4 SD = 1.66	M = 4.29 SD = 1.2	M = 4.86 SD = 1.23

Table 7: Evaluation of Perceptual Qualities for Windhover Contemplative Center. 1 = Least and 7 = Most.

Figure 15: Box and whisker plots of the ratings of the perceptual qualities for the Windhover Contemplative Center image.

Immersive Space Series

For the image of the Immersive Space Series, means and standard deviations were calculated across the four design attributes (Table 8). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on most design attributes.

	Shape	Light	Color	Texture
Overall	M = 4.79 SD = 1.67	M = 5.17 SD = 3.87	M = 5.33 SD = 1.59	M = 5.5 SD = 1.28
Arch/Design Major	M = 4.89 SD = 1.63	M = 5.29 SD = 1.89	M = 5.48 SD = 1.53	M = 5.63 SD = 1.19
Other Major	M = 4.36 SD = 1.82	M = 4.64 SD = 1.78	M = 4.64 SD = 1.74	M = 4.93 SD = 1.54

Table 8: Evaluation of Design Attributes for Immersive Space Series. 1 = Stressful and 7 = Calming.

Figure 16: Box and whisker plots of the ratings of the design attributes for the Immersive Space Series image.

For the image of the Immersive Space Series, means and standard deviations were also calculated across the six perceptual qualities (Table 9). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on most perceptual qualities.

	Naturalness	Beauty	Complexity	Comfort	Uplift	Relaxation
Overall	M = 2.62 SD = 1.46	M = 4.47 SD = 1.56	M = 3.14 SD = 1.49	M = 5.04 SD = 1.76	M = 4.13 SD = 1.26	M = 5.09 SD = 1.53
Arch/Design Major	M = 2.52 SD = 1.33	M = 4.52 SD = 1.46	M = 3.15 SD = 1.44	M = 5.24 SD = 1.75	M = 4.23 SD = 1.23	M = 5.26 SD = 1.53
Other Major	M = 3.07 SD = 1.94	M = 4.29 SD = 2.02	M = 3.14 SD = 1.79	M = 4.14 SD = 1.56	M = 3.71 SD = 1.33	M = 4.36 SD = 1.39

Table 9: Evaluation of Perceptual Qualities for Immersive Space Series. 1 = Least and 7 = Most.

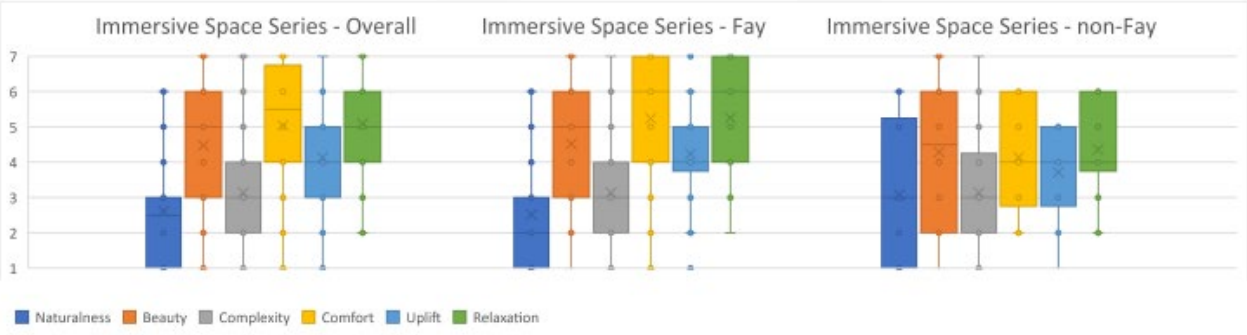

Figure 17: Box and whisker plots of the ratings of the perceptual qualities for the Immersive Space Series image.

The Retreat

For the image of The Retreat, means and standard deviations were calculated across the four design attributes (Table 10). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on most design attributes.

	Shape	Light	Color	Texture
Overall	M = 4.68 SD = 1.53	M = 5.39 SD = 1.32	M = 5.62 SD = 1.18	M = 5.24 SD = 1.28
Arch/Design Major	M = 4.66 SD = 1.4	M = 5.39 SD = 1.33	M = 5.65 SD = 1.16	M = 5.24 SD = 1.24
Other Major	M = 4.79 SD = 2.08	M = 5.43 SD = 1.28	M = 5.5 SD = 1.29	M = 5.21 SD = 1.53

Table 10: Evaluation of Design Attributes for The Retreat. 1 = Stressful and 7 = Calming.

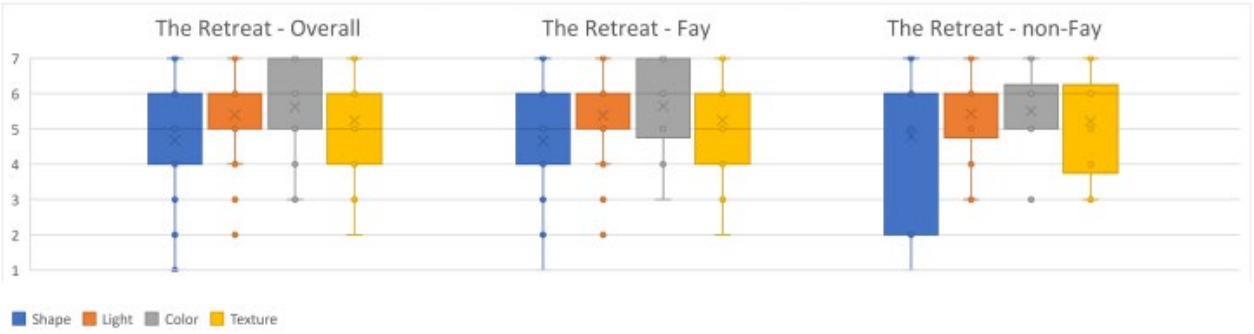

Figure 18: Box and whisker plots of the ratings of the design attributes for the image of The Retreat.

For the image of The Retreat, means and standard deviations were also calculated across the six perceptual qualities (Table 11). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on all perceptual qualities.

	Naturalness	Beauty	Complexity	Comfort	Uplift	Relaxation
Overall	M = 3.45 SD = 1.57	M = 5.2 SD = 1.56	M = 5.14 SD = 1.48	M = 5.66 SD = 1.33	M = 5.43 SD = 1.29	M = 5.58 SD = 1.33
Arch/Design Major	M = 3.35 SD = 1.47	M = 5.17 SD = 1.47	M = 5.24 SD = 1.42	M = 5.68 SD = 1.25	M = 5.5 SD = 1.18	M = 5.65 SD = 1.2
Other Major	M = 3.86 SD = 1.96	M = 5.29 SD = 1.98	M = 4.71 SD = 1.68	M = 5.57 SD = 1.7	M = 5.14 SD = 1.7	M = 5.29 SD = 1.82

Table 11: Evaluation of Perceptual Qualities for The Retreat. 1 = Least and 7 = Most.

Figure 19: Box and whisker plots of the ratings of the perceptual qualities for the image of The Retreat.

The Well

For the image of The Well, means and standard deviations were calculated across the four design attributes (Table 12). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on most design attributes.

	Shape	Light	Color	Texture
Overall	M = 5.74 SD = 1.46	M = 5.62 SD = 1.54	M = 5.39 SD = 1.48	M = 5.25 SD = 1.58
Arch/Design Major	M = 5.83 SD = 1.37	M = 5.79 SD = 1.4	M = 5.44 SD = 1.53	M = 5.32 SD = 1.61
Other Major	M = 5.36 SD = 1.82	M = 4.86 SD = 1.92	M = 5.21 SD = 1.25	M = 4.93 SD = 1.49

Table 12. Evaluation of Design Attributes for The Well. 1 = Stressful and 7 = Calming.

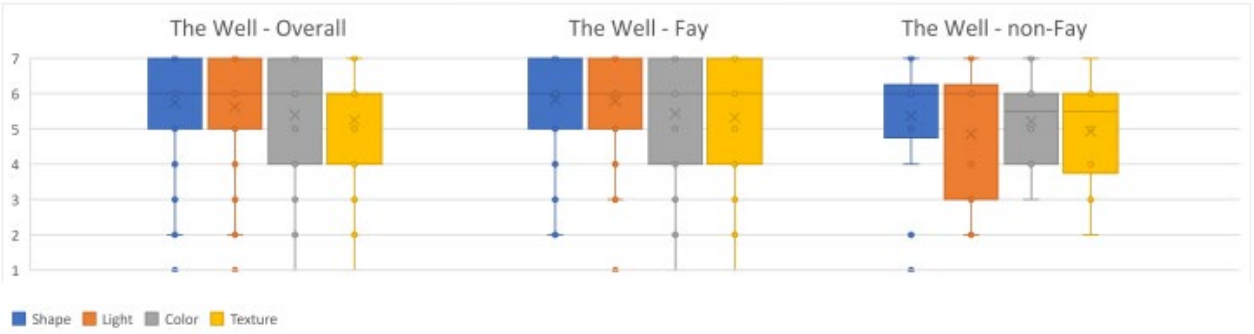

Figure 20: Box and whisker plots of the ratings of the design attributes for the image of The Well.

For the image of The Well, means and standard deviations were also calculated across the six perceptual qualities (Table 13). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on most perceptual qualities.

	Naturalness	Beauty	Complexity	Comfort	Uplift	Relaxation
Overall	M = 3.71 SD = 1.82	M = 4.53 SD = 1.39	M = 2.99 SD = 1.6	M = 4.96 SD = 1.73	M = 4.72 SD = 1.43	M = 5.2 SD = 1.57
Arch/Design Major	M = 3.61 SD = 1.78	M = 4.55 SD = 1.39	M = 2.87 SD = 1.52	M = 5.08 SD = 1.67	M = 4.79 SD = 1.44	M = 5.23 SD = 1.59
Other Major	M = 4.14 SD = 1.99	M = 4.43 SD = 1.45	M = 3.5 SD = 1.91	M = 4.43 SD = 1.95	M = 4.43 SD = 1.4	M = 5.07 SD = 1.54

Table 13: Evaluation of Perceptual Qualities for The Well. 1 = Least and 7 = Most.

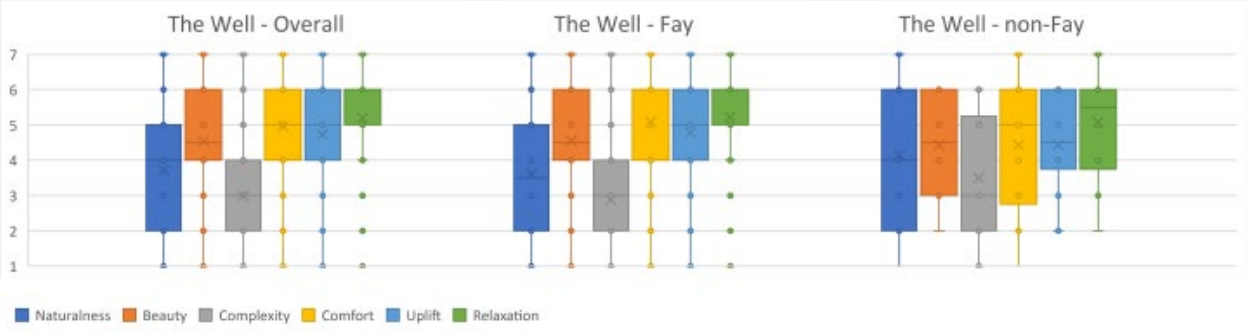

Figure 21: Box and whisker plots of the ratings of the perceptual qualities for the image of The Well.

Inscape Meditation Studio

For the image of Inscape Meditation Studio, means and standard deviations were calculated across the four design attributes (Table 14). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on all design attributes.

	Shape	Light	Color	Texture
Overall	M = 5 SD = 1.63	M = 5.18 SD = 1.56	M = 4.59 SD = 1.69	M = 5.13 SD = 1.36
Arch/Design Major	M = 5.05 SD = 1.53	M = 5.31 SD = 1.51	M = 4.68 SD = 1.62	M = 5.24 SD = 1.25
Other Major	M = 4.79 SD = 2.12	M = 4.64 SD = 1.74	M = 4.21 SD = 1.97	M = 4.64 SD = 1.74

Table 14. Evaluation of Design Attributes for Inscape Meditation Studio. 1 = Stressful and 7 = Calming.

Figure 22: Box and whisker plots of the ratings of the design attributes for the Inscape Meditation Studio image.

For the image of Inscape, means and standard deviations were also calculated across the six perceptual qualities (Table 15). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on almost all perceptual qualities.

	Naturalness	Beauty	Complexity	Comfort	Uplift	Relaxation
Overall	M = 3.13 SD = 1.73	M = 5.04 SD = 1.58	M = 4.95 SD = 1.64	M = 4.53 SD = 1.46	M = 5.74 SD = 1.15	M = 4.93 SD = 1.42
Arch/Design Major	M = 3.15 SD = 1.73	M = 5.03 SD = 1.62	M = 5.03 SD = 1.6	M = 4.55 SD = 1.35	M = 5.79 SD = 1.13	M = 5.03 SD = 1.4
Other Major	M = 3.07 SD = 1.82	M = 5.07 SD = 1.44	M = 4.57 SD = 1.83	M = 4.43 SD = 1.91	M = 5.5 SD = 1.22	M = 4.5 SD = 1.45

Table 15: Evaluation of Perceptual Qualities for Inscape Meditation Studio. 1 = Least and 7 = Most.

Figure 23: Box and whisker plots of the ratings of the perceptual qualities for the Inscape Meditation Studio image.

AYC

For the image of AYC, means and standard deviations were calculated across the four design attributes (Table 16). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on almost all design attributes.

	Shape	Light	Color	Texture
Overall	M = 4.84 SD = 1.29	M = 5.54 SD = 1.35	M = 5.26 SD = 1.29	M = 5.17 SD = 1.3
Arch/Design Major	M = 4.89 SD = 1.23	M = 5.61 SD = 1.37	M = 5.48 SD = 1.18	M = 5.42 SD = 1.17
Other Major	M = 4.64 SD = 1.55	M = 5.21 SD = 1.25	M = 4.29 SD = 1.33	M = 4.07 SD = 1.33

Table 16. Evaluation of Design Attributes for AYC. 1 = Stressful and 7 = Calming.

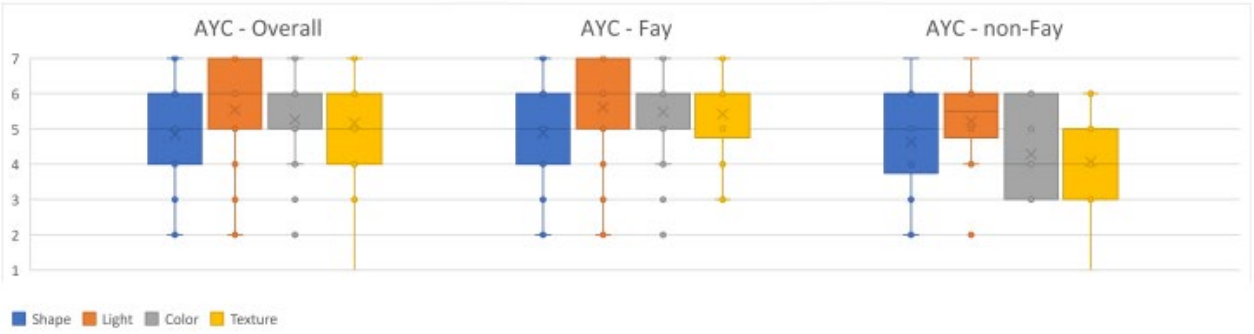

Figure 24: Box and whisker plots of the ratings of the design attributes for the AYC image.

For the image of AYC, means and standard deviations were also calculated across the six perceptual qualities (Table 17). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on most perceptual qualities.

	Naturalness	Beauty	Complexity	Comfort	Uplift	Relaxation
Overall	M = 5.97 SD = 1.26	M = 4.54 SD = 1.5	M = 3.28 SD = 1.33	M = 4.34 SD = 1.44	M = 4.86 SD = 1.25	M = 5.07 SD = 1.24
Arch/Design Major	M = 6.13 SD = 1.09	M = 4.71 SD = 1.49	M = 3.29 SD = 1.32	M = 4.29 SD = 1.44	M = 4.98 SD = 1.22	M = 5.26 SD = 1.2
Other Major	M = 5.29 SD = 1.73	M = 3.79 SD = 1.37	M = 3.21 SD = 1.42	M = 4.57 SD = 1.45	M = 4.29 SD = 1.27	M = 4.21 SD = 1.05

Table 17: Evaluation of Perceptual Qualities for AYC. 1 = Least and 7 = Most.

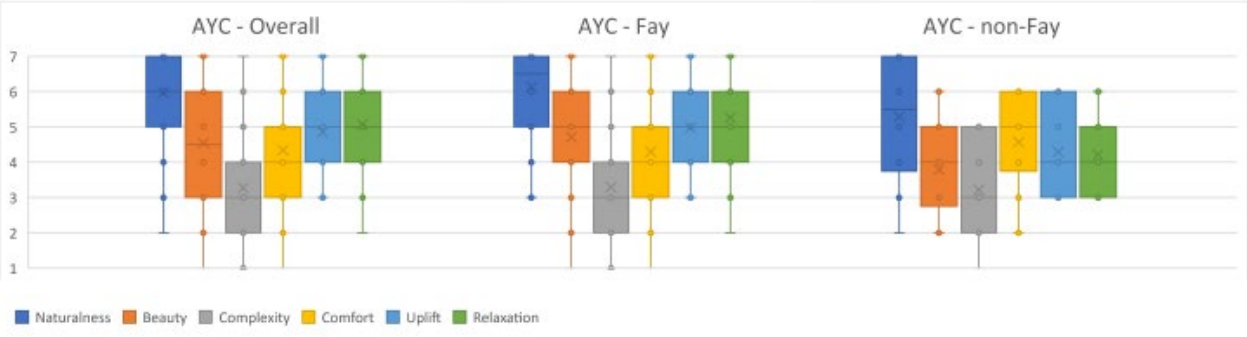

Figure 25: Box and whisker plots of the ratings of the perceptual qualities for the AYC image.

Meditation Space for Creation

For the image of the Meditation Space for Creation, means and standard deviations were calculated across the four design attributes (Table 18). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on all design attributes.

	Shape	Light	Color	Texture
Overall	M = 5.3 SD = 1.5	M = 5.97 SD = 1.11	M = 4.99 SD = 1.65	M = 5.14 SD = 1.64
Arch/Design Major	M = 5.23 SD = 1.45	M = 5.98 SD = 1.08	M = 4.87 SD = 1.67	M = 5.05 SD = 1.66
Other Major	M = 5.64 SD = 1.74	M = 5.93 SD = 1.27	M = 5.5 SD = 1.45	M = 5.57 SD = 1.5

Table 18. Evaluation of Design Attributes for Meditation Space for Creation. 1 = Stressful and 7 = Calming.

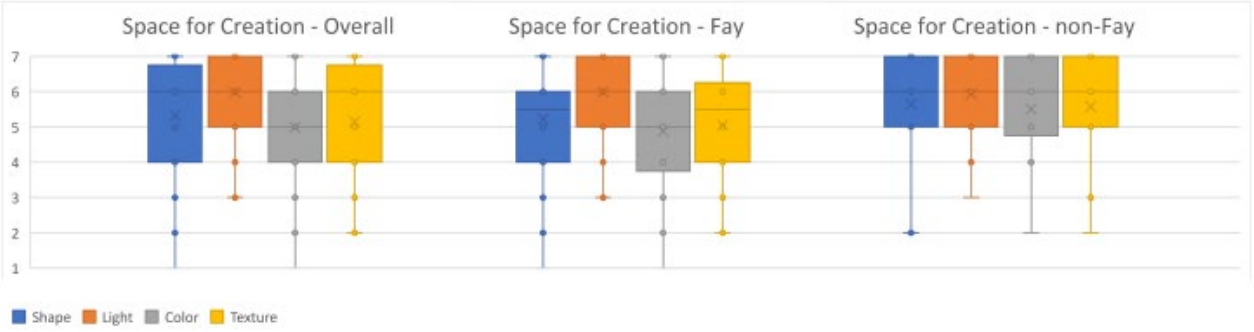

Figure 26: Box and whisker plots of the ratings of the design attributes for the Meditation Space for Creation image.

For the image of Meditation Space for Creation, means and standard deviations were also calculated across the six perceptual qualities (Table 19). Box and whisker plots of the means and standard deviations indicate a more dispersed response for the non-architecture/design students on all perceptual qualities.

	Naturalness	Beauty	Complexity	Comfort	Uplift	Relaxation
Overall	M = 2.74 SD = 1.73	M = 5.36 SD = 1.43	M = 1.71 SD = 1.22	M = 3.91 SD = 1.81	M = 5.16 SD = 1.39	M = 5.11 SD = 1.26
Arch/Design Major	M = 2.6 SD = 1.69	M = 5.31 SD = 1.51	M = 1.89 SD = 1.19	M = 3.69 SD = 1.83	M = 5.13 SD = 1.35	M = 5.08 SD = 1.28
Other Major	M = 3.36 SD = 1.82	M = 5.57 SD = 1.02	M = 2 SD = 1.41	M = 4.86 SD = 1.41	M = 5.29 SD = 1.59	M = 5.21 SD = 1.19

Table 19: Evaluation of Perceptual Qualities for Meditation Space for Creation. 1 = Least and 7 = Most.

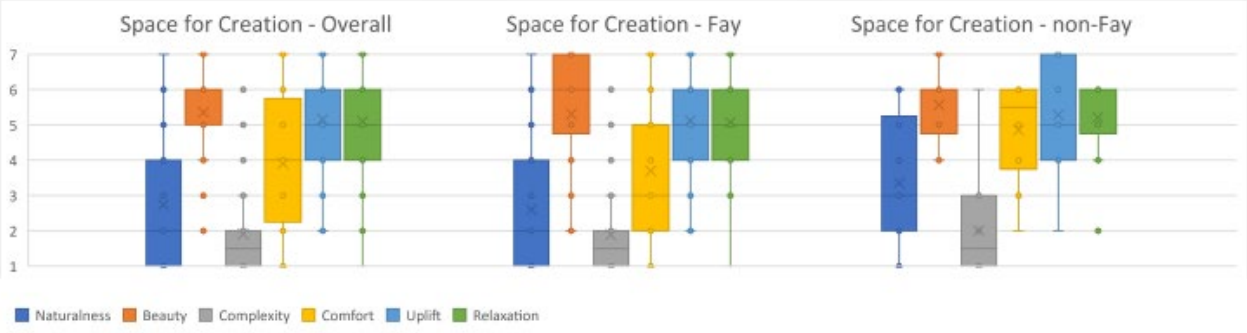

Figure 27: Box and whisker plots of the ratings of the perceptual qualities for the Meditation Space for Creation image.

Discussion

The study examined how design and non-design students evaluated images of spaces of meditation and retreat. These spaces are specifically intended to moderate stress and overstimulation. The analysis focused on designed interior spaces of meditation and retreat in terms of specific design attributes associated with calming or peaceful evaluations and the experiential qualities of the spaces. The study also set out to compare differences in how students from the Fay Jones School of Architecture and Design and students from schools within the University of Arkansas perceived qualities of architectural spaces. Due to the small number of non-design students, those results are not addressed in this discussion.

Shape

The literature regarding shape suggests that spaces that are curved or curvilinear are rated positively and the findings from this study partially support those findings. The Well, one of only two curvilinear spaces in the study, was rated as most calming. This aligns with previous research suggesting that interior environments with curvilinear shapes are perceived as more pleasurable and relaxing than rectilinear ones.[123,124,125,126,127] Therme Vals, Windover Contemplative Center, and Meditation Space for Creation were also evaluated as calming in terms of shape. Specific to all of these rectilinear spaces is a permeability with views of nature. In contrast, the image of The Retreat's low score suggested that spaces of confinement do not feel as calm. Table 20 illustrates the means and standard deviations of shape for each image.

[123] Augustin, Place Advantage, 56.
[124]Cobum et al., "Psychological and Neural Responses", 224.
[125]Dazkir and Read, "Furniture Forms."
[126]Hevner, "Colors and Lines."
[127]Spence, "Sense of Place," 6.

IMAGE	 The Well	 Therme Vals	 Meditation Space for Creation	 Windhover Contemplative Center
SHAPE RATING	5.74 SD: 1.46	5.38 SD: 1.31	5.3 SD: 1.50	5.29 SD: 1.32
IMAGE	 Inscape Meditation Studio	 AYC	 Immersive Space Series: Coves	 The Retreat
SHAPE RATING	5 SD: 1.64	4.84 SD: 1.29	4.79 SD: 1.67	4.68 SD: 1.53

Table 20: Means and standard deviations for the shape rankings of each image.

Light

Previous research findings provide inconsistent outcomes regarding lighting preferences. Some studies found that dim and non-uniform lighting was more relaxing than bright lighting,[128,129] but other research found that natural light increased well-being and mood.[130] The Therme Vals image was rated the most calming by the overall sample in terms of light, while the image of the Meditation Space for Creation was rated the second-most calming. Since these two images were the only two that depicted bright, natural, and diffused light, the current data suggest that spaces with this type of light were perceived as more calming than spaces with other types of lighting. In contrast, the Immersive Space image and the Inscape Meditation Studio image were rated the least calming in terms of light. Since these two images depicted dim, artificial, strongly colored, and direct light, this suggests that spaces with this type of lighting

[128]TCP, "Light and Color."
[129]Tomassoni et al., "Psychology of Light," 1219.
[130]Giang, "Productivity."

were perceived as less calming than spaces with bright, natural, and diffused light. Table 21 illustrates the means and standard deviations of light for each image.

IMAGE	 Therme Vals	 Meditation Space for Creation	 Windhover Contemplative Center	 The Well
LIGHT RATING	6 SD: 1.28	5.97 SD:1.11	5.68 SD: 1.48	5.62 SD: 1.54
IMAGE	 AYC	 The Retreat	 Inscape Meditation Studio	 Immersive Space Series: Coves
LIGHT RATING	5.54 SD: 1.35	5.39 SD: 1.32	5.18 SD: 1.56	5.17 SD: 3.87

Table 21: Means and standard deviations for the light rankings of each image.

Color

Previous research on the psychological effects of color found that cool desaturated colors create more calming spaces, while warm saturated colors are more energizing. The findings from this study support those findings. In terms of color, the Therme Vals image was rated the most calming by the overall sample. Since the Therme Vals image was the only image that depicted multiple desaturated cool colors, the data suggest that spaces with desaturated cool colors were perceived as more calming overall than spaces with saturated, warm, or neutral colors. This aligns with previous research stating that desaturated cool colors create restful and calming spaces and that multiple cool colors in a space create a particularly calming effect.[131,132,133]

[131]Augustin, *Place Advantage*, 49.
[132]Augustin, *Place Advantage*, 50.
[133]Kaya and Epps, "Color and Emotion," 397.

Further, the Inscape Meditation Studio image was rated the least calming in terms of color. Since it depicted multiple bright and saturated warm colors, the data suggest that spaces with saturated, warm colors were perceived as less calming than desaturated cool colors. This aligns with previous research stating that saturated warm colors create spaces that are energizing and stimulating rather than calming.[134,135] Table 22 illustrates the means and standard deviations of color for each image.

IMAGE	 Therme Vals	 The Retreat	 Windhover Contemplative Center	 The Well
COLOR RATING	5.91 SD: 1.25	5.62 SD: 1.18	5.43 SD: 1.33	5.39 SD: 1.48
IMAGE	 Immersive Space Series: Coves	 AYC	 Meditation Space for Creation	 Inscape Meditation Studio
COLOR RATING	5.33 SD: 1.59	5.26 SD: 1.29	4.99 SD: 1.65	4.59 SD: 1.69

Table 22: Means and standard deviations for the color rankings of each image.

Texture

The literature regarding texture suggests that matte smooth textures are calming, while shiny rough textures are energizing. The findings from this study support those findings. In terms of texture, the Immersive Space image was rated the most calming by the overall sample, closely followed by the Therme Vals image and the Windhover Contemplative Center image. The

[134]Augustin, *Place Advantage*, 49.
[135]Kaya and Epps, "Color and Emotion," 397.

Immersive Space image depicts matte, smooth surfaces with little variation in texture. The Therme Vals image and the Windhover Contemplative Center image depict increased variation in texture. Further, the Inscape Meditation Studio image was rated the least calming by the overall sample in terms of texture. The Inscape Meditation Studio image depicts shiny wood surfaces and bamboo elements in the dome that form a dynamic curved pattern, so it reads as a highly textured surface. The data suggest that spaces with matte and smooth surfaces are perceived as more calming than spaces with shiny and more textured surfaces, and spaces with fewer variations in textures also appear to be more calming. This aligns with previous research stating that smooth and matte textures are more relaxing than shiny and rough textures, and that the more textures in a space vary, the more energizing the space becomes.[136,137] Table 23 illustrates the means and standard deviations of texture for each image.

IMAGE	 Immersive Space Series: Coves	 Therme Vals	 Windhover Contemplative Center	 The Well
TEXTURE RATING	5.5 SD: 1.28	5.45 SD: 1.41	5.45 SD: 1.31	5.25 SD: 1.58
IMAGE	 The Retreat	 AYC	 Meditation Space for Creation	 Inscape Meditation Studio
TEXTURE RATING	5.24 SD: 1.28	5.17 SD: 1.30	5.14 SD: 1.64	5.13 SD: 1.36

Table 23: Means and standard deviations for the texture rankings of each image.

[136]Augustin, *Place Advantage*, 56.
[137]Augustin, *Place Advantage*, 65.

Naturalness

In terms of naturalness, the AYC image was rated the most natural by the overall sample. This appears to be due to the prominent use of exposed wood, including large vertical elements that may remind the viewer of trees. The space also has natural light, and foliage can be seen in the background. The Therme Vals image was rated the second-most natural by the overall sample. This may be due to the pronounced texture of the quartzite rock, the water, the natural light, and the trees in the image. Further, the Immersive Space image was rated the most artificial by the overall sample. This appears to be due to the artificial blue lighting and the artificial materials in the space. The data suggest that spaces with natural light, natural materials, and exterior connections to nature were perceived as more natural than spaces without those qualities.

When considering the average ratings based on shape, light, color, and texture, both the AYC image (5.2) and the Therme Vals image (5.685) were rated more calming on average than the Immersive Space image (5.197). This suggests that the perceived naturalness of a space may have a positive correlation with how calming it is perceived to be. This aligns with previous research suggesting that wood has been shown to have psychological benefits because it is natural,[138] natural light increases mood and well-being,[139] and architecture that is similar to nature or connects us to nature has a positive psychological impact.[140] Table 24 illustrates the means and standard deviations of naturalness for each image.

[138]Nyrud and Bringslimark, "Interior Wood Use," 208.
[139]Giang, "Productivity."
[140]Ricci, "Psychological Impact," 19.

IMAGE	 AYC	 Therme Vals	 Windhover Contemplative Center	 The Well
NATURALNESS RATING	5.97 SD: 1.26	5 SD: 1.66	4.3 SD: 1.61	3.71 SD: 1.82
IMAGE	 The Retreat	 Inscape Meditation Studio	 Meditation Space for Creation	 Immersive Space Series: Coves
NAURALNESS RATING	3.45 SD: 1.57	3.13 SD: 1.73	2.74 SD: 1.73	2.62 SD: 1.46

Table 24: Means and standard deviations for the naturalness rankings of each image.

Beauty

In terms of beauty, the Therme Vals image was rated the most beautiful by the overall sample. This appears to be due to the bright, natural, and diffused light, the desaturated cool colors in the image, the prominent textures of quartzite rock and water, and the view to the exterior showing trees. The image of the Windhover Contemplative Center was rated the second-most beautiful by the overall sample. This appears to be due to the natural light in the image, the desaturated warm tones, the prominent use of wood, and the views to the exterior showing trees. Further, the Immersive Space image was rated the least beautiful by the overall sample. This may be because of the dim, artificial, and direct light in the space, the dark blue color, and the plain surfaces. The data suggest that spaces with natural light, desaturated colors, and natural materials were perceived as more beautiful than spaces with artificial light, saturated colors, and artificial materials.

When considering the average ratings based on shape, light, color, and texture, the study found that the Therme Vals image (5.6) and the Windhover Contemplative Center image (5.46) were rated more calming on average than the Immersive Space image (5.2). This suggests that the perceived beauty of a space may have a positive correlation with how calming it is perceived to be. Table 25 illustrates the means and standard deviations of beauty for each image.

IMAGE	 Therme Vals	 Windhover Contemplative Center	 Meditation Space for Creation	 The Retreat
BEAUTY RATING	5.92 SD: 1.42	5.51 SD: 1.21	5.36 SD: 1.43	5.2 SD: 1.56
IMAGE	 Inscape Meditation Studio	 AYC	 The Well	 Immersive Space Series: Coves
BEAUTY RATING	5.04 SD: 1.58	4.54 SD: 1.50	4.53 SD: 1.39	4.47 SD: 1.56

Table 25: Means and standard deviations for the beauty rankings of each image.

Complexity

The image of The Retreat was rated the most complex by the overall sample. This appears to be due to the arrangement of spaces and lounge furniture around the pool as well as the design of the ceiling, which both provide pattern and repetition within the space. The image also depicts a variety of colors, materials, and textures. The Inscape Meditation Studio image was rated second-most complex by the overall sample. This appears to be due to the variety of bright colors shown in the image as well as the bamboo elements in the dome that form a dynamic curved pattern that reads as a highly textured surface. Further, the Meditation Space for

Creation image was rated the simplest by the overall sample. This appears to be due to its stark white color, smooth matte texture, and clear rectangular shape. The data suggest that spaces with more repetition, pattern, and variety of colors and textures were perceived as more complex than spaces without these aspects.

When considering the average ratings based on shape, light, color, and texture, the study found that both the image of The Retreat (5.23) and the Inscape Mediation Studio image (4.98) were rated less calming on average than the Meditation Space for Creation image (5.35). This suggests that the perceived complexity of a space may have a negative correlation with how calming it is perceived to be. This aligns with previous research stating that spaces with "moderate complexity and high order" are pleasing, while those with "too much visual complexity and too little order" are repelling.[141] Table 26 illustrates the means and standard deviations of complexity for each image.

IMAGE	 The Retreat	 Inscape Meditation Studio	 Windhover Contemplative Center	 Therme Vals
COMPLEXITY RATING	5.14 SD: 1.48	4.95 SD: 1.64	4.16 SD: 1.59	3.99 SD: 1.66
IMAGE	 AYC	 Immersive Space Series: Coves	 The Well	 Meditation Space for Creation
COMPLEXITY RATING	3.28 SD: 1.33	3.14 SD: 1.49	2.99 SD: 1.60	1.91 SD: 1.22

Table 26: Means and standard deviations for the complexity rankings of each image.

[141]Augustin, *Place Advantage*, 59.

Comfort

The image of The Retreat was rated the most comfortable by the overall sample. This may be due to the diffused light, the neutral color palette, the lounge furniture around the pool, and the various material textures in the space that contrast with the blue water. The Therme Vals image was rated the second-most comfortable by the overall sample. This may be due to the bright, natural, and diffused light, the natural textures of rock and water, the desaturated cool colors in the image, and the view to the exterior showing trees. Further, the Meditation Space for Creation was rated the least comfortable by the overall sample. This may be due to its stark white color, its clearly defined rectangular shape, and surfaces that look smooth and hard. This data suggests that spaces with natural textures and materials and desaturated colors (not saturated colors or white) were perceived as more comfortable than spaces without those attributes. Table 27 illustrates the means and standard deviations of comfort for each image.

IMAGE	 The Retreat	 Therme Vals	 Immersive Space Series: Coves	 The Well
COMFORT RATING	5.66 SD: 1.33	5.29 SD: 1.34	5.04 SD: 1.76	4.96 SD: 1.73
IMAGE	 Inscape Meditation Studio	 AYC	 Windhover Contemplative Center	 Meditation Space for Creation
COMFORT RATING	4.53 SD: 1.46	4.34 SD: 1.44	4.18 SD: 1.68	3.91 SD: 1.81

Table 27: Means and standard deviations for the comfort rankings of each image.

Uplift

The Therme Vals image was rated the most uplifting by the overall sample. This may be due to the bright, natural, and diffused light, the highly textured surface of the rock and its interaction with the water, the desaturated cool colors, and the view to the exterior showing trees. The Inscape Meditation Studio image was rated the second-most uplifting by the overall sample. This appears to be due to the variety of bright saturated colors shown in the image as well as the shiny wood flooring and the bamboo elements in the dome that form a dynamic curved pattern. Further, the Immersive Space image was rated the least uplifting by the overall sample. This appears to be due to its dark blue color, dim artificial lighting, and smooth textures. The data suggest that spaces with brighter colors, bright lighting, and highly textured surfaces were perceived as more uplifting than spaces with darker or neutral colors, dim lighting, and smooth matte surfaces. This aligns with previous research stating that bright lighting makes people more alert and productive,[142] natural lighting increases mood and energy,[143] and shiny or rough textures are energizing while matte smooth textures are relaxing.[144,145] Table 28 illustrates the means and standard deviations of uplift for each image.

[142]Tomassoni et al., "Psychology of Light," 1219.
[143]Giang, "Productivity."
[144]Augustin, *Place Advantage*, 56.
[145]Augustin, *Place Advantage*, 65.

IMAGE	 Therme Vals	 Inscape Meditation Studio	 The Retreat	 Meditation Space for Creation
UPLIFT RATING	5.83 SD: 1.39	5.74 SD: 1.15	5.43 SD: 1.29	5.16 SD: 1.39
IMAGE	 AYC	 The Well	 Windhover Contemplative Center	 Immersive Space Series: Coves
UPLIFT RATING	4.86 SD: 1.25	4.72 SD: 1.43	4.62 SD: 1.36	4.13 SD: 1.26

Table 28: Means and standard deviations for the uplift rankings of each image.

Relaxation

The Therme Vals image was rated the most relaxing by the overall sample. This appears to be due to the bright, natural, and diffused light, the desaturated cool colors in the image, the prominent textures of quartzite rock and water, and the view to nature. The image of The Retreat was rated the second-most relaxing by the overall sample. This appears to be due to the diffused light, the neutral tones of the materials in combination with the water, and the arrangement of lounge spaces and furniture around the pool. Further, the Inscape Meditation Studio image was rated the least relaxing by the overall sample. This appears to be due to the variety of bright colors shown in the image, the bright artificial light, and the bamboo elements in the dome that form a dynamic curved pattern that reads as a highly textured surface. The data suggest that spaces with natural light, desaturated colors, and smooth textures were perceived as more relaxing than spaces with artificial light, saturated colors, and highly textured surfaces. Table 29 illustrates the means and standard deviations of relaxation for each image.

IMAGE	 Therme Vals	 The Retreat	 Windhover Contemplative Center	 The Well
RELAXATION RATING	5.97 SD: 1.33	5.58 SD: 1.33	5.41 SD: 1.22	5.2 SD: 1.57
IMAGE	 Meditation Space for Creation	 Immersive Space Series: Coves	 AYC	 Inscape Meditation Studio
RELAXATION RATING	5.11 SD: 1.26	5.09 SD: 1.53	5.07 SD: 1.24	4.93 SD: 1.42

Table 29: Means and standard deviations for the relaxation rankings of each image.

Standard Deviation

An examination of the data plots (Figures 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27) across all design attributes and environmental qualities reveals differences between the architecture- and design-trained students in the Fay Jones School and students of other majors. The plots reveal that the standard deviations of the image ratings of the non-Fay Jones School students were greater than those of the ratings of the Fay Jones School students in 63% of the analyses. This may be because Fay Jones School students have similar sensibilities, which led them to the study of architecture and design. It may also be because Fay Jones students have been taught to think about architecture in a specific way.

Stress Scores and Rating of Images as Calming

Stress scores for all participants ranged from 8 to 35 based on a 0 to 40 scale identified by the Perceived Stress Scale. According to the stress scale, a low stress score is between 0-13, a moderate stress score is between 14-26, and a high stress score is between 27-40. The five

highest stress scores were 35, 32, 30, 30, and 29, while the five lowest stress scores were 8, 11, 11, 12, and 12. When considering the average ratings based on shape, light, color, and texture among the participants with the highest stress score, the Immersive Space image was rated most calming on average. This may be because the space is small, dark, and womblike. Also, on average, the participants with the highest stress scores ranked the images as more calming than those with the lowest stress scores. This is affirming and demonstrates that the people with the highest stress scores were responsive to these spaces designed for stress relief.

Conclusion

The findings of this study suggest that the architectural design and experiential qualities of spaces intended for meditation and stress relief impact how the space is perceived as meditative or calming.

This capstone project explored how architecture, specifically interior spaces of meditation and retreat, can be designed to moderate stress and convey a sense of calmness to its occupants. The issues of stress and overstimulation as prominent aspects of today's world, especially in urban conditions and during the COVID-19 pandemic, have brought new attention to the interaction between physical environment and well-being. The findings of this project have provided insight into the design of spaces that moderate stress.

The findings suggest that spaces with curvilinear shapes may prove to be perceived as more calming than spaces with rectilinear ones. Also, spaces with permeable shapes that allow views and access to nature may prove to be perceived as more calming than spaces with defined and enclosed shapes. The data also suggest that spaces with bright, natural, and diffused lighting may prove to be perceived as more calming than spaces with other lighting conditions. The

findings suggest that spaces with desaturated cool colors may prove to be perceived as more calming than spaces with saturated, warm, or neutral colors. Further, the data suggest that spaces with matte and smooth textures may prove to be perceived as more calming than spaces with rough and shiny textures; spaces with fewer variations in textures may also prove to be perceived as more calming than spaces with more variation in textures. The findings suggest that spaces with natural light, natural materials, and exterior connections to nature may prove to be perceived as more calming than spaces with artificial qualities. The data also suggest that spaces perceived as more beautiful may also prove to be perceived as more calming than spaces that are perceived as less beautiful. Further, the findings suggest that spaces with more repetition, more pattern, various colors, and various textures may prove to be perceived as more complex than spaces without these aspects, and spaces perceived as more complex may prove to be perceived as less calming.

The data also suggest that there are subtle differences between how students from the Fay Jones School of Architecture and Design and students from other schools within the University of Arkansas perceive qualities of architectural spaces. In 63% of responses, the standard deviation of the image ratings of the non-Fay Jones School students were higher than those of the ratings of the Fay Jones School students. This may have been because design students have similar sensibilities, or possibly because they have been taught to think about architecture in a specific way.

Further, the study found that the five participants with the highest stress scores rated the Immersive Space image as the most calming on average. This may be because they perceived the space as cozy and womblike due to its small size and dim lighting. Also, the study found that on average, the participants with the highest stress scores ranked the images as more calming than

those with the lowest stress scores. This demonstrates that the people with the highest stress scores were responsive to these spaces designed for stress relief.

While the data were analyzed as independent design elements, the experience of three-dimensional space is complex. The interactions of light on color and texture, the availability of natural views, and many other factors interact to create the final experience. Even more complicating are the individual factors such as the occupants' stress level and mood that the designer cannot control and cannot anticipate. Imagining that a selective analysis of the variables is accurate would not be realistic.

Limitations and Future Work

The limitations of the study provide important context. First, the sample of the study was relatively small and homogenous. The sample consisted of students from the University of Arkansas, the majority of which were students from the Fay Jones School of Architecture and Design. The design students can also be assumed to have a greater than average awareness of Peter Zumthor's Therme Vals. This particular project may have been evaluated differently as a result of its extensive study and publication within the architecture and design communities.
A second point is the method of data collection. Still images were presented on large, high-definition monitors. All participants visited the same site in an effort to control for environmental variation. However, these spaces are intended to be experienced with all the senses, the sounds, temperatures, humidity levels, and tactility that create the unique experience of the environment. Singular, static images and a sterile environment could impact the research findings.

In future work, a larger sample size could be useful, as it could affirm trends suggested by the findings of this study. The survey instruments used provided a foundation for data

analysis, but they could be adjusted to allow additional research to more closely investigate the effects of architecture on stress.

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Appendix A: Stress Questionnaire

Stress Questionnaire

Most questions in this survey ask about your feelings and thoughts **during the last month.** The best approach is to answer fairly quickly and indicate the answer that seems like a reasonable estimate.

1. In the last month, how often have you been upset because of something that happened unexpectedly?

Never	Almost never	Sometimes	Fairly often	Very often
○	○	○	○	○

2. In the last month, how often have you felt that you were unable to control the important things in your life?

Never	Almost never	Sometimes	Fairly often	Very often
○	○	○	○	○

3. In the last month, how often have you felt nervous and stressed?

Never	Almost never	Sometimes	Fairly often	Very often
○	○	○	○	○

4. In the last month, how often have you felt confident about your ability to handle your personal problems?

Never	Almost never	Sometimes	Fairly often	Very often
○	○	○	○	○

5. In the last month, how often have you felt that things were going your way?

Never	Almost never	Sometimes	Fairly often	Very often
○	○	○	○	○

6. In the last month, how often have you found that you could not cope with all the things that you had to do?

Never	Almost never	Sometimes	Fairly often	Very often
○	○	○	○	○

7. In the last month, how often have you been able to control irritations in your life?

Never	Almost never	Sometimes	Fairly often	Very often
○	○	○	○	○

8. In the last month, how often have you felt that you were on top of things?

Never	Almost never	Sometimes	Fairly often	Very often
○	○	○	○	○

9. In the last month, how often have you been angered because of things that happened that were outside of your control?

Never	Almost never	Sometimes	Fairly often	Very often
○	○	○	○	○

10. In the last month, how often have you felt that difficulties were piling up so high that you could not overcome them?

Never	Almost never	Sometimes	Fairly often	Very often
○	○	○	○	○

11. How often do you feel sensitive to your physical environment?

Never	Almost never	Sometimes	Fairly often	Very often
○	○	○	○	○

12. Gender: _____

13. What is your year level?

Freshman	Sophomore	Junior	Senior	Fifth year	Graduate student
○	○	○	○	○	○

14. Are you a student at the Fay Jones School of Architecture and Design?

Yes	No
○	○

Seat

Appendix B: Image Evaluation Questionnaire

Evaluation of Interior Spaces Set A

Rate each image based on the qualities presented by circling the number that best characterizes how you feel about the space. There is no right or wrong answer.

First Image

The **shape** of this room is

	Stressful	1	2	3	4	5	6	7	Calming

The **light** in this room is

	Stressful	1	2	3	4	5	6	7	Calming

The **colors** of this room are

	Stressful	1	2	3	4	5	6	7	Calming

The **textures** of this room are

	Stressful	1	2	3	4	5	6	7	Calming

This room looks

	Artificial	1	2	3	4	5	6	7	Natural

This room looks

	Ugly	1	2	3	4	5	6	7	Beautiful

This room looks

	Simple	1	2	3	4	5	6	7	Complex

This room looks

	Uncomfortable	1	2	3	4	5	6	7	Comfortable

This room looks

	Depressing	1	2	3	4	5	6	7	Uplifting

This room looks

Stressful	1	2	3	4	5	6	7	Relaxing

Seat

Appendix C: Images Used for Data Collection

Figure 28: The Therme Vals, Vals, Switzerland, 1996

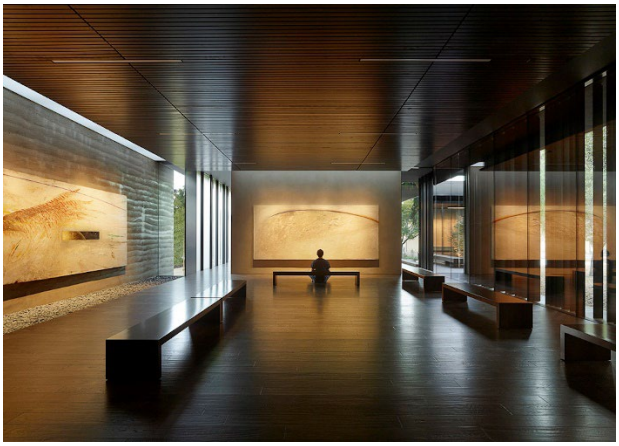


Figure 29: Windhover Contemplative Center, Stanford, CA, 2014

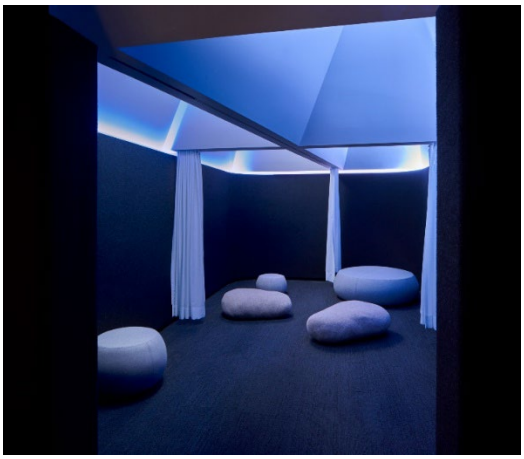


Figure 30: Immersive Space Series: Coves, San Francisco, CA, 2017

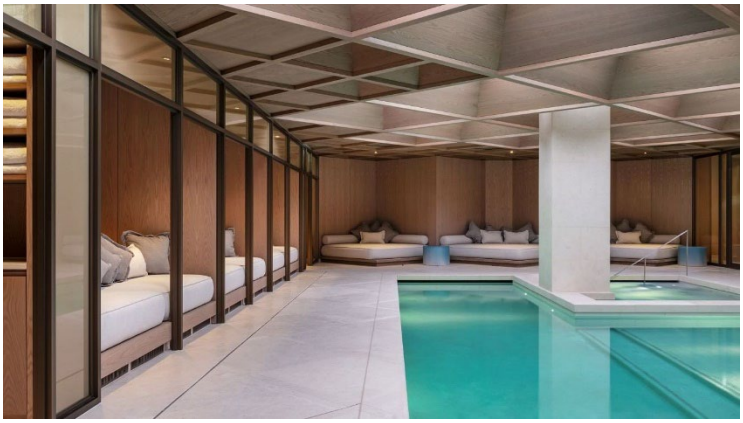


Figure 31: The Retreat (in The Londoner Hotel), London, England, 2021

Figure 32: The Well - Mediation Room, New York, NY, 2019

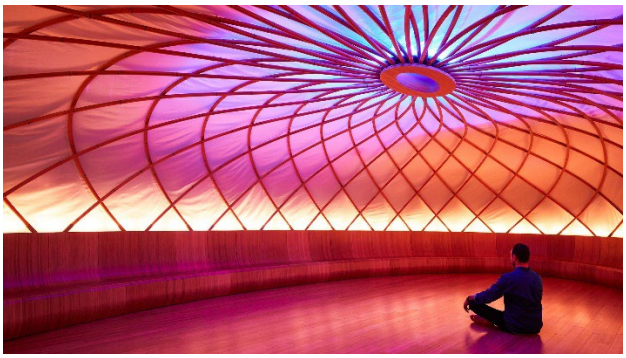


Figure 33: Inscape Meditation Studio, New York, NY, 2016

Figure 34: AYC, Santiago, Chile, 2014

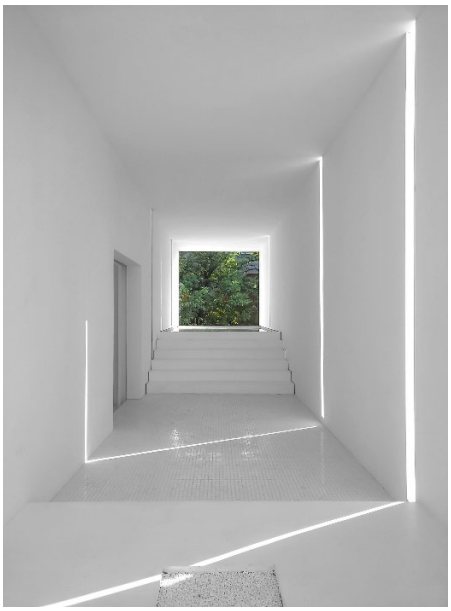


Figure 35: Meditation Space for Creation, Beijing, China, 2019

Appendix D: Additional Diagrams

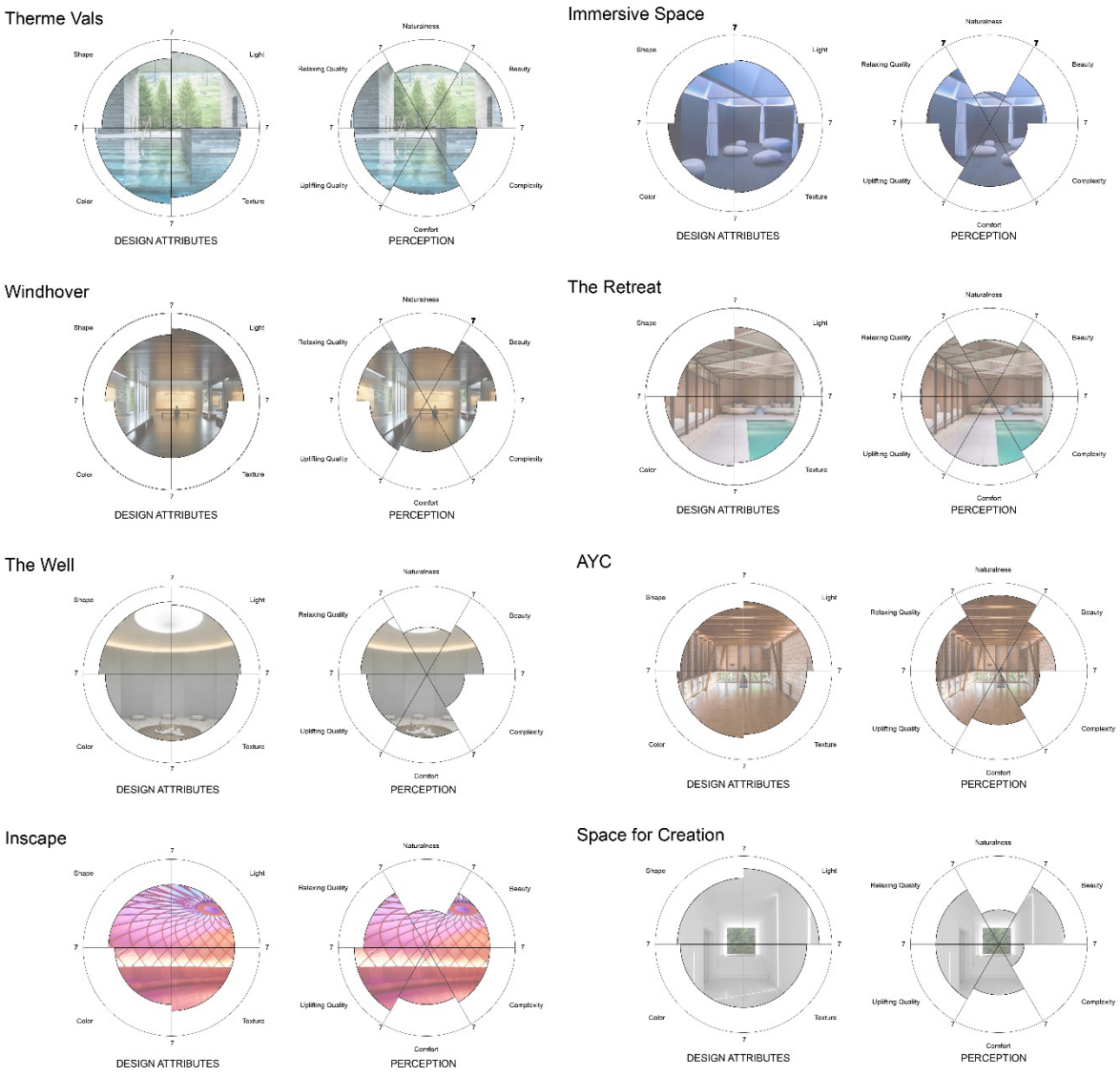


Figure 36: Pie diagrams illustrating the average ratings of the spaces.

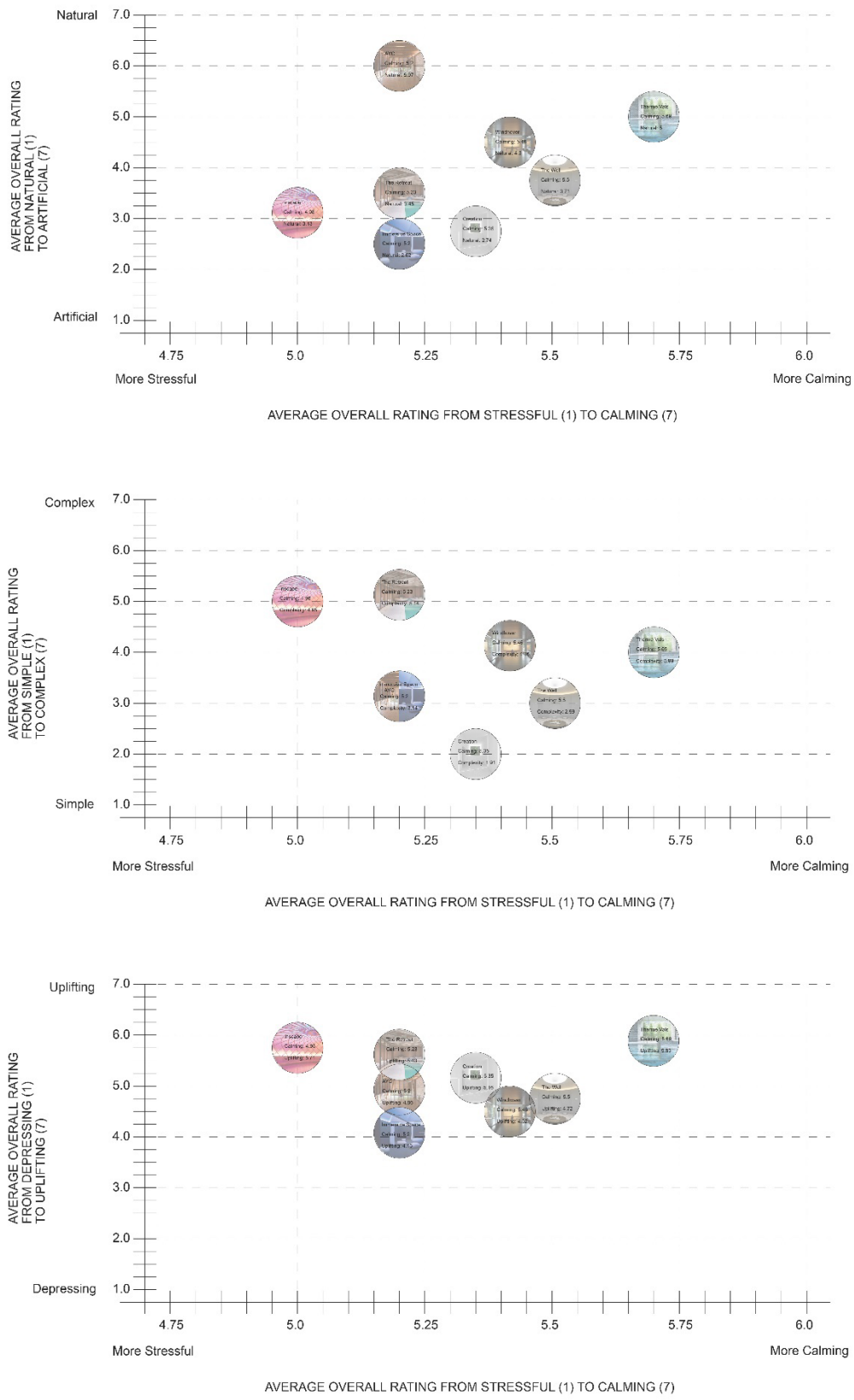
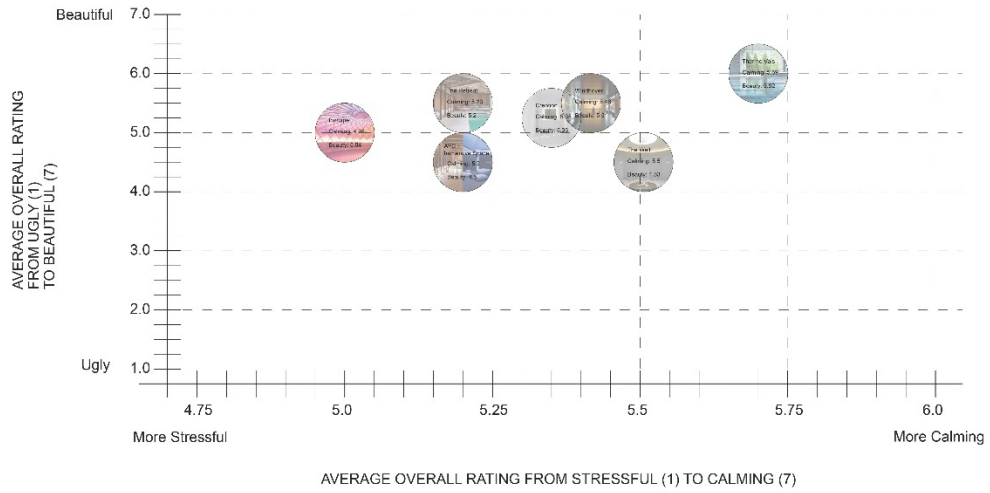
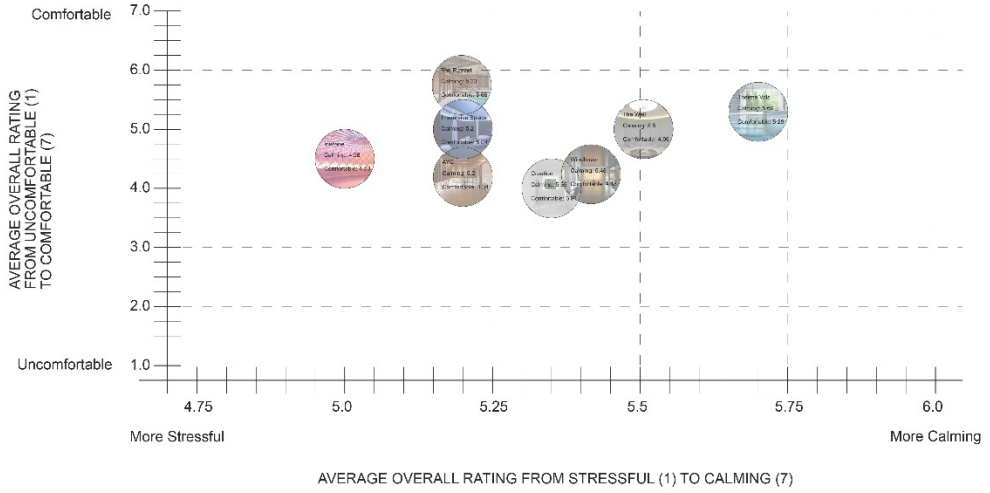


Figure 37: Timeline diagrams of perceptual aspect ratings by stressful/calming ratings.





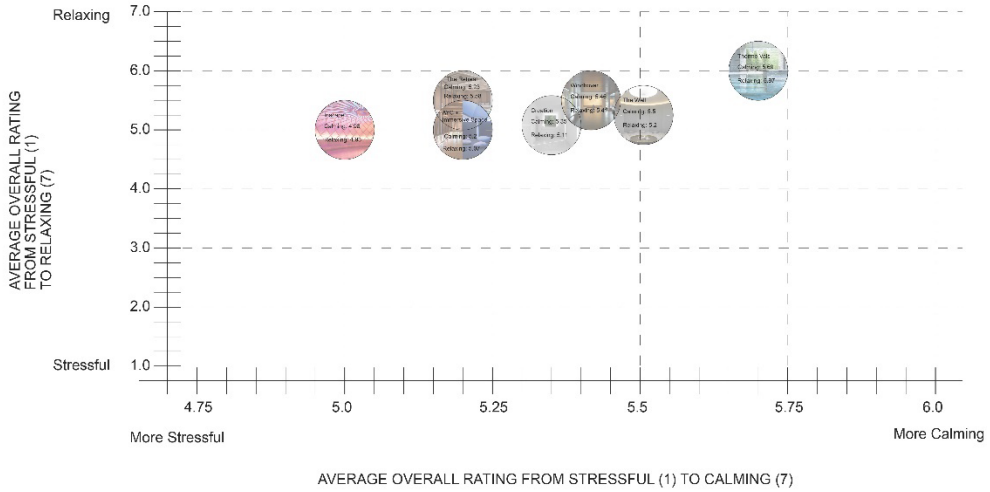


Figure 38: Timeline diagrams of perceptual aspect ratings by stressful/calming ratings.