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Growing Concerned: How Societal Stress Relates to Plants in the Home

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GROWING CONCERNED:
HOW SOCIETAL STRESS RELATES TO PLANTS IN THE HOME

By

TRENTON BIRDWELL, Bachelor of Arts in English

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To the city of Paris,

Where much of this work was completed

ABSTRACT

Design trends are constantly in flux, but the reasons why people prefer new trends are not readily apparent. This thesis brought together multiple aspects of interior design to investigate how design has changed. After a review of available studies, the researcher decided to focus on natural design in homes because this area has previous research upon which to build. This study compared data to examine how stress in America relates to plant imagery. The research questions asked what, if any, relationship exists between societal stress and the use of plants, plant-like objects, and window views.

Measures of stress included hospitalization, violent crime, and poverty rates. The setting for examination was the United States from 1965 to 2020. The study used items in photographs to generate variables. The results indicated there was a positive, moderate relationship between the number of plants used in a home and the rate of hospitalization for the same year. When controlling for the size of plants, there was a strong, positive relationship. The data supported a negative, weak relationship between the use of plants and the poverty rate. The analysis concluded that there is little relationship between social factors and the view from the windows in a room. There was not enough evidence to support any connection between social factors and plant-like objects. This showed that in years when hospitalization rates were higher, there was an increased number of plants in magazine photographs.

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“Thank God for trees.”

-Laura Thyme, *Rosemary & Thyme*

CHAPTER 1

Introduction

Every generation of artists must ask themselves: “What will we create?” Logically, the task of those who follow is to ask: “Why did they create what they did?” This thesis ventured into the difficult aspects of such a question. The investigation focused on the context of interior architecture. The goal was to look for connections between societal changes and design changes.

Interior architecture’s role as an art medium often merges with its functions. Unlike other art, architecture (both interior and exterior) performs a variety of tasks in addition to demands that it be beautiful. Of course, this is not to say that architecture should be evaluated as more or less important than a “non-functioning” artwork, but rather, it indicates that assessing architecture involves criteria that cannot apply to the painting or the pot. The literature review of this document explored several systems used to evaluate interior architecture. The researcher examined these methods to apply them in a contemporary socio-architectural context and produced an instrument to examine how the use of design elements changes in society. This instrument measured the frequency of plants in interior spaces to examine how in-home plant use relates to societal stress. The final pages of this document propose applications of the findings for future study.

Generations of artists and philosophers have sought universal rules of design. As early as the Greeks, philosophers and sages pondered the mysteries of beauty. Jay

Appleton outlined this historical development in the context of art and landscape evaluation with his seminal work *The Experience of Landscape* (Appleton 1975). Discussions of beauty help to construct ideas about what is valuable and explain how effective design can be crafted in contemporary spaces. Research examining why styles change can help designers of the future make more informed decisions about what a society wants and needs.

Statement of the Problems – Why Ideals Change

In *The Architecture of Happiness*, Alain de Botton asked a question: "Why do we change our minds about what we find beautiful?" (de Botton, 2006). Answering his question was the inspirational catalyst for this study. The context of his interrogation was why architectural styles go in and out of fashion in a chapter entitled "Why ideals change." He compared French palaces and modern concrete to show how design rationales change dramatically between centuries. De Botton offered little prescription regarding the value of art, but instead emphasized how motivations for style can come from multiple sources in life. He then argued that these motivations should be sought internally and defined by facets of human happiness. The researcher determined after looking at the literature that a narrow focus on a single aspect of design would be the most concise way to study how design changes. Because review of literature emphasized the longstanding relationship between humans and the natural world, plants became the primary focus of the study. There are several theoretical difficulties with this kind of

study. This first chapter lists some of these difficulties and provides solutions for the purpose of conducting research.

Three key problems arise when trying to answer de Botton's question about design. First is the cyclic relationship between humans and the environment – just as peoples' ideals inform the way they design their space, so too the patterns in the environment can affect individuals' values. For example, people might wonder if they picked a chair because they really liked it or because it was culturally popular at the time. The connection between humans and their environment is inescapable. The presence of a sensing, physical body mandates the connection to physical surroundings. This relationship will cycle back and forth as long as that person is alive and aware.

The second problem of de Botton's question is the nature of observation, specifically the way people change attitudes in response to being observed. The human element makes it difficult to record objective phenomena. One of the first forays into environmental psychology research emphasized this difficulty: a series of studies conducted in the 1920s exploring effects of lighting levels on productivity. The study, conducted at the Hawthorne Works of the Western Electric Company, found that although worker productivity increased when light levels increased, the same workers remained productive even when light levels decreased until clearly inefficient for work (Canter, 1975). Instead of a natural observation, the participants changed their behavior in relation to being observed and the results could not indicate a most useful lighting condition.

The final problem of de Botton's question is the sheer enormity of its scale. Not only is a large amount of information required to synthesize an answer, but the area in question is the philosophy of art and design – a field notorious for the subjectivity of terms. While the literature has developed its lexicon for centuries, it has been less successful in usefully defining new terms (Appleton 1975). Within the scope of design literature, only a few scientific studies have looked at societal effects upon aesthetic choices; even fewer have done so at a large scale. Most prior studies have investigated localized issues in design, typically by collecting observations to record users' experiences in a given space (Dosen & Ostwald, 2017). The narrowness of these studies makes them valuable for testing specific problems while also making them easy to perform and interpret, but because hyperfocus is largely the norm, there is a lack of statistical evidence on a large scale. Nevertheless, much of daily life is governed by overarching aesthetic choices: trends are carried out *en masse* from year to year, usually to the detriment of the style that comes before. Certain angles fall out of vogue and entire design philosophies are rewritten and disseminated without being tested to determine effects within the culture.

De Botton's query and these three problems informed the direction of the present narrative: *observation*, *exploration*, and *explanation* of the reciprocal relationship between people and spaces. Several disciplines lent themselves to answering a problem so cross-sectional: among them were interior design, architecture, psychology, sociology,

economics, and art history. The relatively new field of environmental psychology provided invaluable support in this endeavor.

Purpose of the Study – Answering the Question

The question from *The Architecture of Happiness* indeed presented a challenge, but the prize of an answer remained enticing. This section addresses the three challenges of de Botton's question and creates a series of objectives to guide the flow of ideas in this document.

As stated by the first problem, the reciprocal relationship between people and the environment is hard to delineate. The two-way effect of humans creating space and being psychologically affected by space puts the relationship in a recursive loop that makes evaluation difficult. Intentionally choosing a perspective helped here. If people want to ask, "Are we designing well?" then they must first define what it means to design well. A user-centered approach provided the necessary structure to address the recursion. Additionally, this approach aligned with contemporary concerns in the design community relating to how the built environment addresses emotional and physical needs (Vischer, 2008). Focusing on the user end of the human/environment relationship provided a place to start forming clear research objectives. Good chairs support the frame of the occupants to encourage good posture. Good design in a home anticipates the requirements of residents then provides adequate resources for the task at hand. This presented a way to break the cycle: focusing on how users create the best physical and emotional outcomes

in their specific circumstances. Determined by this context, the research objective focused on the relationship between interior design and human well-being.

The second problem applies to any study involving human nature – the effects of observation on results. The Hawthorne study revealed the complications of direct observation inherent to environmental research, but revisiting the results provided insight into how this kind of study might be performed today (Canter, 1975). Many students of the human sciences will recognize the Hawthorne example as a way to explain the effect of researcher presence on results, but it emphasized another important discovery. As Canter wrote…

> The Hawthorne results did actually show relationship between environment and behavior. The behavioral changes did not have a direct and simple environmental cause, simply forcing the workers to work more or less effectively whether they were interested in so doing or not. The behavioral changes related to the workers' *interpretation* of the environmental modifications. It was what these modifications indicated about the relationships between management and works that mattered. (p. 125)

Here Canter emphasized that workers' feelings about managers mattered most when determining worker productivity. This bodes well for future research on two counts: (1) the relationship between people and the environment includes not just physical elements but also the psychological component of perception and (2) projects involving human reactions to the environment could be enhanced by separating the observer from the

human element under observation. This study accomplished both by incorporating data from mental health studies and using historical social artifacts for analysis.

Lastly, there arises the problem of lacking substantial data for a question so vast. De Botton's question sets a nearly impossible goal without a considerable body of work upon which to build. Little research exists to explain the neurological motivations for certain aesthetic choices and many aesthetic principles remain subjective. However, a few recent studies have looked at the way humans interact with the natural environment, specifically plants and plant-like materials (Gillis et al 2015; Van den Bosch & Bird, 2018). These studies provided the basis for the present research method: focusing on the role that nature and natural elements play in the human-built environment. Authors have posed theories about such a relationship for centuries, but only recently has there been scholarly, statistical research into what this relationship is like and from where it comes. This project addressed the scarcity of knowledge and subjectivity of terms by gathering literature and synthesizing ideas from multiple areas of study.

Despite a lack of understanding regarding neurological mechanisms for aesthetic preference, the relationships and patterns remain (Purani & Kumar, 2018; Wirchrowski et al., 2021). By delving into the complexity of these connections and asking pertinent questions, a better understanding of how people are affected by their spaces and why their ideals change may emerge. The answers to such questions can then be used as guidelines to customize physical spaces that better serve the physical and emotional well-being of occupants. For example, if people know that certain design strategies relieve

stress while others create excitement, living spaces could be tailored to create user-specific design strategies within the built environment. Buildings, rooms, and furniture could all work in tandem with the psychotherapist, allowing for a more holistic approach to mental and physical health. In knowing that humans affect and are affected by their environment, and by showing how that environment interacts with people, ideal strategies can be explored and produced. To do so for this study, clear objectives were established to guide the investigation. Based on the three research problems, the following study focused research on the users' experiences, separated the observers from the observed, and brought together multiple disciplines for analysis.

Research Objectives

The literature review contained in the next chapter parses through the aesthetics writing and psychological studies that culminate in this work. Because this type of research does not have a uniform approach, it draws from a variety of disciplines to structure the methods enumerated in chapter three. The research objectives established which part of the human/environment relationship was explored and how. The primary goal was to illustrate how the natural design elements of a space related to a humans' experiences, and how this relationship behaves. This study focused on the relationship between societal stress and plants in the home. The literature provided the framework to define the natural elements and explain why certain design aspects were selected for consideration while why others were not. The methodology section developed relevant aspects of the literature into variables and a scheme for analysis.

In summation the objective of the research was:

(1) The researcher looked for a relationship between causes of social stress in society and the amount of biological imagery in home design magazines.

The scheme to analyze the visual data drew upon scientific studies and principles regarding the psychological effects of visual phenomena. This study employed a photo-ethnographic instrument and data collection method to code photos sourced from the interior design and architecture magazines. This process created photo data to compare with the sociological stress data. These instruments examined the human/environment relationship longitudinally to see if people change their environment related to how they experience it. Where such a relationship did exist, the application of design strategies can be reconsidered with the relationship in mind. Where such paradigms did not present themselves statistically, the lack of data would indicate that the rationale behind the human/environment relationship must be sought in a different place or manner.

Limitations of the Study

The limitations of this study were not unique to aesthetic research. Among them was the ever-present subjectivity of terms and ideas (Appleton, 1975). Another limitation was the perspective of an individual scholar in analysis. Because the work of a single researcher can entail the personal biases of the author, steps were taken to address this concern in the methods section, principally the creation of a photo-observation method that emphasized objective observations and definitions. The philosophical scope of the project also created issues for research. As stated previously, the nature of this work

required synthesizing from a multitude of disciplines. The range of this information made it difficult to fully analyze every part and give concise explanations. The methodology in the following chapters took steps to control the area of study to produce valid results.

One final note is that information discovered here does not preclude other evolutions in the design field. Just as this research could present one reason for changing trends, so could the next paper, and the next, and the next. The difficulty and beauty of this kind of work are that it does not perform alone but rather works in chorus with centuries of other books, papers, journals, and essays. In conducting research that asks questions of human nature and reason, investigators raise themselves to the level of complexity that human experience assuredly contains. By engaging critically with the difficult question of "What will we create?" rather than fighting against it, one allows the creative force to explain itself, and in doing so, becomes more mindful of what it means to be human.

Chapter 2

Review of Literature

Philosophy and History

Conversations about nature have a long history. The ancient Greeks had a range of discourses on the subject (Appleton, 1975). In the 18th and 19th centuries, the philosophical love of nature presented itself in the literature of the American Transcendentalist movement and the British Romantic period. Jay Appleton described how Romantic poets of this time espoused reverence for nature in their writings, especially William Wordsworth and Samuel Taylor Coleridge (Appleton, 1975). These ideas were expanded upon by John Ruskin and William Morris who, as critics in the Arts and Crafts movement, encouraged natural forms and materials in art and the home (Blewitt, 2019). These writers and designers marked an early move toward nature-based interior design strategies.

Parallel to this period, a growing body of art criticism emerged in Germany that would become the European and international Modernist movements. Among the most influential German art critics was Wilhelm Worringer (1881-1965) whose 1908 thesis on art and architecture was foundational in developing many ideas of the Modernist philosophy (Holdheim 1979; Spanos 1970). In his thesis, *Abstraction and Empathy, a Contribution to the Psychology of Style,* Worringer developed earlier ideas of art critic Theodore Lipps (1851-1914) and Lipps's concept of *Einfuhlung* ("empathy" or "feeling

into"). This concept, termed Empathy in English, came into development in the 18th century before blooming in the 19th century among writers like Lipps and Worringer, then later falling out of favor in the 20th century. Lipps saw Empathy as a way of interacting with art and wrote about it as having two types, positive and negative – the positive as a feeling of liberty and pleasure from experiencing art as the work demands, and the negative as a conflict between self-activation and the motivation of the artwork (Worringer 1908/2014, p. 6). Worringer expanded on Lipps's concept of positive Empathy to structure his own version of the term, calling the aesthetic enjoyment of Empathy "objectified self-enjoyment" (p. 7). These ideas of an interpersonal art interaction provide a historical and philosophical basis to examine the interactions between natural imagery in the home and social phenomena like stress.

Worringer developed the ideas from Lipps and Austrian art historian Alois Riegl (1858-1905) to create a way of examining art through a spectrum of two polar ideas: Empathy which encompassed emotive, naturalistic art, and Abstraction, the art of the crystalline and geometric (Curtis & Elliott, 2014; Helg, 2015). Worringer's philosophy hinged on the idea of a nature-based art spectrum. He believed that the evaluation of art within that spectrum was based on the individual's unique personal experience with the artwork. The highly naturalistic art of Empathy was seen as organic and nature-embracing, whereas the art of Abstraction shunned organic shapes in favor of the linear graph and geometric curve. Within Worringer's framework, both sides of the art spectrum have value depending on a person's present psychological state. John Dewey

(1859-1952) gave an equivalent way of viewing art in his writings. His book, *Art as Experience*, posited that art and perception do not stand alone but instead work together to create an experience that is unique to every pairing of artwork and viewer (1959). These philosophical developments are key when building a study to examine how the art of the home relates to sociological factors in society. They provide a philosophical basis for measuring how the psychological makeup of a group can affect what they value in art and design.

A few years after Worringer published his seminal work in 1908, some key developments occurred that pushed the discussion of the human/nature relationship beyond the philosophical sphere and into the scientific world. In a seemingly unlikely place, scholars have pointed to the rise of tuberculosis in the late 19th- and early 20th centuries as a possible influence on the modernist movement. In her article on the subject, Mary Campbell wrote "tuberculosis was a disease closely associated with the rapid growth of industrialization and a poorly nourished working class who lived in insalubrious, overcrowded conditions" (2005, p. 463). Here again, there was an observed relationship between people and their environments, but instead of the pastoral musings of Greek philosophers or the high philosophy of the Germans, the modern residents were discussing how they get sick in their cities and buildings. Before the release of the tuberculosis vaccine in 1921, people fought the disease by tailoring the environment to aid the body's own immune response (Campbell, 2005). These remedies included fresh air, sunlight, and keeping the body in a reclined position. Thus, in an early move towards

health-centric furniture design, health communities produced recliners for large rest porches and constructed sanatoria in dry alpine regions. These design strategies held sway during the early stages of the modernist movement and through the mid-20th century (Campbell 1999, 2005).

Alongside the tuberculosis cures, the early 20th century saw the rise of many health design practices that are still in use today. These included contemporary disease protocols, safety codes, and building standards. Just 50 years before the tuberculosis outbreaks of the 1900s, John Snow led his now-famous investigation into the Broadstreet water pump, paving the way for modern epidemiology and showing a clear connection between public health and public utilities (Morantz, 2004). In 1911, the Triangle factory fire in New York set off a wave of health and safety regulations across the United States aimed at promoting health and safety in the workplace (Greenwald, 2011). These historical events represented an emerging populace opening its eyes to how the built environment can physically affect its users. When World War II ended in 1945, the United States embarked on an ambitious building campaign to meet the demands of a rapidly growing nation. Suddenly, understanding how people interact with interior environments seemed more important than in previous centuries, and studies like the Hawthorne reports of the Western Electric Company anticipated the field of environmental psychology.

Research Premises and Current Theory Frameworks

For at least two millennia, philosophers and poets have been recording their sacred experiences of the natural world. During the last century, scholars started to scientifically examine how the environment affects mental and physical experiences; it remains to investigate further how these interactions occur and how they can be put to good use. Enter the field of environmental psychology.

Using these concepts for study required specification of the philosophical premises under which this research is conducted. The first premise assumed here is that art and design are *experiential* as Dewey asserted and Appleton examined in depth (Appleton, 1975). This idea finds that although people can share similar experiences, people in a space will have a unique reaction that does apply to everyone the same way. A second premise holds that people will edit surroundings, when possible, to suit their differing needs. The third theoretical premise, hinted at in the works of Worringer and the Romantic poets (Appleton, 1975; Worringer 1908/2014), and discussed further in the next section, is that humans have an innate relationship with nature described here as *biophilia*.

In 1984, Harvard Biologist Edward O. Wilson theorized that humans have an "innate tendency to focus on life and lifelike processes" (Wilson). He termed his philosophy "biophilia" in a book of the same name, borrowing the word from German social psychologist Erich Fromm (1900-1980). Since Wilson's initial proposal, the

biophilic hypothesis has bloomed (McGee, 2015), and it is under this psychological theory that this exploration was conducted.

Since its inception, the biophilic hypothesis has garnered widespread attention in avenues of environmental psychology and prompted multiple test studies (see next section on Studies and Data). It has also spawned a network of psychological theories including Attention Restoration Theory (ART) and Stress Reduction Theory (SRT) that have been used in the exploration of testable hypotheses. An important clarification on these points is that qualifiers of biophilia and the biophilic hypothesis are not set in stone. Multiple frameworks have attempted to outline these ideas, and several studies have included mixed versions of those frameworks (Berto et al., 2017; McGee et al., 2015; Ryan et al., 2014).

The lack of centralized definitions combined with the inherent subjectivity of perceptual research have made evaluating experiences of biophilia difficult, but not without merit. The intersection of psychology and art has been fraught with hesitancy, and one writer to illuminate this struggle was Jay Appleton. In writing *The Experience of Landscape*, Appleton drew upon an extensive body of earlier works like the romantic poets and Dewey to theorize a relationship between people and their landscape. In doing so, he devised a set of theoretical constructs for analyzing landscape imagery, among them *prospect* and *refuge* (1975). His work provides clarity and structure within the multiple biophilic ideas.

Appleton defined prospect as an unimpeded opportunity to take in one's surroundings and refuge as an opportunity to hide and see without being seen. Like de Botton's query, Appleton posited a question, "What is it about landscape and why do we like it?" In his line of inquiry, Appleton spawned a new angle in the discussion of human interaction with nature. He termed his approach "habitat theory," and it has since been applied in widespread fashion to several other corners of the human/nature relationship arguments. Habitat theory suggested that people have relationships with their environments that are inspired by their ancestral ties to the earth, i.e., that animal instincts could still play a part in environmental decision making and forge certain perceptions about the environment (Appleton 1975). Many scholars have since applied the aspects of prospect and refuge to research in landscape design and environmental psychology.

A few years later, Roger Ulrich embraced and expanded Appleton's line of theorizing in his own work which considered how people generate personal responses to natural aesthetics (Ulrich 1983). Ulrich developed methods for evidence-based design in healthcare environments, and Stress Reduction Theory (SRT) was a product of his research (Van den Bosch & Bird, 2018). Ulrich's model for SRT assumed that "certain environmental features elicit rapid affective reactions which occur without conscious processing" (Van den Bosch & Bird, 2018). He also said that restorative features like vegetation or water could move a person into a more positive emotional state and decrease stress levels. Ulrich's work showed how natural elements could quickly and effectively reduce a person's stress level. Studies of this theory have demonstrated that

views of nature can provide better restoration than built scenes, but they did not confirm the restorative primacy of any one feature over others (Van den Bosch & Bird, 2018). Ulrich's work also showed that people preferred spaces with access to nature and good light (1993). In a groundbreaking report, he demonstrated how patients recovering from gallbladder surgery who were exposed to views of nature needed shorter hospital stays and less nurse intervention and pain medication (Ulrich 1984). Roger Ulrich's work and concurrent healthcare studies showed growing support for the positive influence of nature on the healthcare environment (1997).

Alongside the Ulrich model, Attention Restoration Theory (ART) emerged to evaluate spaces under a nature-based approach. This model by Stephen and Rachel Kaplan proposed that people have a limited capacity to pay attention to something and that this capacity becomes drained by "directed attention" and conversely restored by "fascination" (Van den Bosch & Bird, 2018). Like Ulrich's stance, the Kaplans theorized a psychological relationship to the environment, termed Information Processing Theory (IPT), which also asserted that nature plays a psychological role in a person's assessment of the environment. In their studies of content-based categories, the Kaplans theorized that when comparing different environment types, "those [environments] with human intrusions are less preferred, and those where nature dominates the built elements receive a much more favorable response" (Kaplan & Kaplan, 1989, p. 49). The Kaplans hypothesized that the selective pressures of evolution would favor the cognitive ability to determine which environmental features were safest (Van den Bosch & Bird, 2018). They

speculated that from evolution humans acquired positive responses to four environmental characteristics: *coherence* and *legibility* (to understand the environment), and *complexity* and *mystery* (to encourage exploration; Van den Bosch & Bird, 2018). The Kaplan model claimed that natural elements can affect psychological states and inhibit boredom (Kaplan, 1995). Their research had a broader scope than Ulrich's, while still maintaining demonstrable connections between nature, health restoration, and preference. Ulrich's health-related studies mainly focused on landscape integration and were less likely to include environments that encourage health promotion. His reports illustrated that biological elements could help sick patients recover from illness and improve general conditions. Thus far, little scholarly attention has addressed how health-promoting environments may benefit *already* healthy individuals (Abdelaal & Soebarto, 2019). This likely results from Ulrich's focus on mainly healthcare facilities. Under the Kaplans, biophilia took on a broader scope, and their four new aspects are often included alongside Appleton's prospect and refuge in the greater conversation about habitat theory.

Despite their detailed nature, the Appleton, Ulrich, and Kaplan frameworks do not extend to interior spaces. For that perspective, one must turn to Grant Hildebrand's examination of the home. Hildebrand proposed that interior architecture could be viewed through the lens of environmental theory and was among the earlier writers to employ the idea in a studied interior context (Stamps, 2006). Hildebrand's work applied Appleton's ideas to the interior by focusing the environmental theories on buildings such as Frank Lloyd Wright's houses. Hildebrand argued that emotional formations by occupants of

Wright's houses were a direct result of the way that Wright used space to emphasize prospect-refuge characteristics (Dawes & Ostwald, 2014). Hildebrand's writing provided a framework to begin evaluating interiors in the context of the psychological elements from earlier authors as part of the greater environmental psychology discussion.

Previous Studies and Data

Evidence has suggested that humans have much to gain from exposure to the natural environment (Gillis et al., 2015). This generally accepted proposal has prompted the development of building standards that include natural components to promote psychological well-being among users. These standards include the Living Building Challenge and the International WELL Building Standard (Gillis et al., 2015). (A note: these should be considered as distinct from *green* building standards like LEED and BREAM which focus on a building's ecological impact and relationship with an environment.) Studies have shown that plants can have a beneficial effect on stress and pain tolerance, natural lighting can improve mood and communication for nurses, and that acute stress may be relieved by exposure to nature (Gillis et al 2015; Van den Bosch & Bird, 2018). Other studies have corroborated the restorative effect of biophilic servicescapes on consumers' psychological states, attention, and mood (Purani et al., 2018). Some investigations have looked at specific biological materials and their positive connections to user experience. These findings supported the biophilic hypothesis by showing that wooden elements could improve occupant satisfaction and cognitive

performance over concrete (Shen et al., 2020). All of these studies showed how the natural imagery of plants and materials helped reduce stress and improve performance.

In addition to biological integration through plants and natural materials, the data have suggested that the way a space employs visual complexity, as well as orientation and proportion, can generate psychological and physiological responses for users. In a study analyzing student selections of places to sit, Astrid Roetzel found that Appleton's prospect and refuge, as well as lighting, temperature, and the architecture that influences them, could affect the student selection of seating choices between an alcove and an open courtyard (Roetzel, 2020). That same research also noted that personal upbringing could affect the relationship with the environment, citing that some in the group who chose the courtyard did so out of a preference for natural environments, resultant from an outdoorsy upbringing. This study corroborated a 2019 study showing that seating choice will vary depending upon the users' social goals (Keszei et al.).

Although these two studies did not explicitly give psychological application for the findings, both demonstrated that, whether consciously or not, there was an adaptive process for reacting to the environment based on fundamental needs aligning with prospect and refuge. The fact that personal, historical relationships with the environment, like upbringing, could affect choices also supports the idea that decision-making processes regarding space have internal motivations related to more than just the physical space itself. These findings underscore the importance of operating under the user-centric approach as outlined in the philosophies of Worringer and Dewey.

Other research has shown that individuals can intuit prospect-refuge characteristics based on lighting choices and will switch preferences if communication is a desired social goal (Barazaqa et al., 2013). Light also had a strong influence on the spatial characteristic of *mystery* as defined in the Kaplan model – the amount of information a scene might promise if someone could walk further into it (Stamps, 2007). Research also demonstrated that room proportions can affect a person's comfort level with room-width constituting the most efficacious element (Stamps, 2006). This perception of room size was unaffected by boundary roughness, showing that a room with textured walls would not necessarily pose a difficulty in perceiving its true size (Stamps et al., 2006). This spatial reasoning skill was further validated considering studies that demonstrate how well people perceive their own spaces. A study using *isovists*, a measure of observable geometric space, showed that participants performed well on navigation and orientation tasks demonstrating that people were able to perceive the size of isovists quite well (Wiener & Franz, 2004). In other words, people could generally assess the size of physical and visual space accurately. Research has shown that gender and education did not affect the study outcomes when investigating prospect/refuge and landscape preference theory (Dosen & Ostwald, 2017).

Limitations of Current Research

Evidence from neuroscience research shows the psychological value of previous studies regarding the biophilic hypothesis. However, a key point concerning biophilia maintains that its psychological efficacy must be considered distinct from concepts of

beauty. In general, there have always been disparities between measures attempting to quantify beauty because there is no universal definition for aesthetic sense (Maleki et al., 2017). One investigation into the perception of beauty found that there was no relationship between judgments of beauty and feelings of safety in participants' preferred spaces (Shemesh et al., 2017). This informs some of the conclusions based on habitat theory, which stems from the idea that primordial fear can be a motivator for space preference. Someone could consider a beautiful space as unsafe, but a superficially ugly room might feel most secure. Failed attempts to quantify aesthetic measurements also demonstrate the lack of a universal definition for aesthetics. For instance, in 1933 mathematician George D. Birkoff (1884-1944) published a work concerning formal definitions of aesthetics, including a measure M of an object representing the relationship between its order and complexity (Douchova, 2016). Birkoff's longstanding aesthetic measure of geometric shapes, though generally used and discussed in the literature, cannot be supported with empirical data (Douchova, 2016). Another limitation of the current psychological research is that while some studies contain statistical results in favor of ART or SRT within the biophilic framework, these studies do not adequately explain the underlying neurological response. Additionally, biophilia should not be taken as a cure-all environment strategy that could cancel out negative effects like a flaw in design or an unsafe structure (Joye, 2011). No amount of natural light will keep a foundation from cracking.

Finally, although the research at the beginning of this section can be shown to support the biophilic hypothesis, some contradiction persists. As recently as 2021, a study of natural imagery on patient satisfaction showed that while natural imagery had a statistically significant effect on patient ratings of rooms, the effects of natural imagery on patient quality of stay, sleep, and overall care, though positive, were not statistically significant (Wichrowski et al., 2021). Research also revealed that while a building with biophilic qualities could score high on a scale measuring perception of restoration (a scale derived from the Kaplan aspects), this did not guarantee that a building had actual restorative qualities (Berto et al., 2015). In tandem, these ideas indicate that more research is required to truly understand the link between biophilia and health restoration. A way to do that is by measuring biophilic qualities in a room and comparing them directly with social data.

Stress As a Variable

Discussion in scholarship indicates mental health around the globe is on the decline, specifically in achievement-oriented Euro-American societies (Burešová et al., 2020; Goodwin et al. 2020). Research among adults in the United States, conducted with data from 2008 to 2018, found increasing anxiety among adult Americans, with the most notable increase occurring among adults ages 18 to 25 (Goodwin et al. 2020). Trends show that mental unhealth appears to be on the rise, possibly stemming from increasing populations or increasing awareness of mental health issues (Baxter et al., 2014). Additionally, a high prevalence of mental disorders such depression, anxiety, and

neurotic disorders leads to higher healthcare costs (Murray et al., 2012). Higher rates of poor mental health and higher medical costs both corroborate a need for further exploration in the areas of mental health (Burešová et al., 2020). Psychological issues are also particularly prevalent among the young, with mental illness being more prevalent and accounting for the largest burden of disease among Western youth (Eckersley, 2011).

Research on the social patterning of stress remains sparse and the multitude of definitions for stress make it hard to agree upon an ideal framework for research (Meyer et al., 2008). Collective stress within a society can also stem from a variety of factors, with some producing stronger effects than others. There are some trends identifiable in the literature that can be useful when trying to make sense of societal stress. One way of looking at mental health is the *dual-continuum framework*, which suggests that mental health is the absence of mental disorders and the simultaneous presence of well-being (Winzer et al. 2014, Burešová et al., 2020). This concept of well-being has gained prominence in recent years, and some studies argue that past research is directed disproportionately at examining ill-health characteristics rather than factors protecting people from mental illness (Wilhelm et al., 2010). This well-being model also fits nicely into the biophilic context, especially when considering the application of ART and SRT. Under this premise, researchers could lay the groundwork to examine how well-being features aid in stress reduction by looking for the presence and effectiveness of biophilic indicators.

When considering the framework for studying mental health, several variables exist within the literature that can be used to analyze stress. Gender is one of the most enduring variables in sociological analysis (Massey, 2007 as cited in Meyer et al. 2008). Women generally experience more stress than men in a given context and are perceived as having higher social difficulty than men (Saleh et al., 2017, Matud et al., 2020). However, within the literature for landscape preferences and prospect/refuge characteristics, there are no strong effects based on gender or education (Dosen & Ostwald, 2017). As such, the researcher chose not to include gender or education as primary factors for stress data included in this study.

Research shows that levels of stress and stress-related illness increase with worsening circumstances. This is defined by people having little control and not knowing how long their circumstances will last (Randle et al., 2017). Scholars divide stress into two categories: *experiential stress* and *structural stress* (Meyer et al., 2008). Experiential stress arises from events and conditions that tax an individual's ability to cope. Structural stress is something like racism which might not be a specific stressful event but still poses a threat to prosperity, esteem, or influence.

The present study focused on experiential stress which includes a variety of testable variables that previous studies have used to evaluate stress. Several of these studies already have examined which experiential factors people reported as most concerning. Factors of highest concern included the cost of living, the well-being of family members, financial security, and personal physical health. Areas of non-concern

were finding a job, education, getting a job they like, and superannuation (Randle et al., 2017). The same study reported that the greatest societal worries people had were violence and crime, national politics, corrupted officials, and the breakdown of moral values. One study used a novel approach of regression trees to look at which factors produced strong interaction effects, theorizing that while some factors may cause stress individually, they could combine to create more stressful outcomes in an individual (Scott, 2011). That study indicated that loneliness, neighborhood quality, and financial strain had high interaction effects to create stress and reported that the perceived stress overall was highest among those with the lowest income (Scott, 2011). The stress literature revealed that personal health, financial strain, and societal unrest were of high importance to individuals, so the researcher chose to use these as measures of stress in the study. This study measured each by using data for rates of hospitalization, rates of poverty, and rate of violent crime respectively. These measures have been used to determine stress in previous studies (Chang, 2019; Browning et al. 2012; Santiago et al. 2011).

Photo-Ethnography

Photo-ethnography is a technique of photo analysis where photos are first gathered into themed groups, then a set of codes is generated to use in analysis (Delve, 2022). The themes usually link photos by meaning or content (e.g. photos of certain room types, or showing particular kinds of views). The codes may contain information about what is in the photograph, like specific items. Codes might also have information about

the researchers' judgements of a photograph, like whether subjects know they are being photographed or what the photographer's intent was. This constitutes a way to process groups of photographic data. Within the grounded theory of coding, a few distinctions exist to guide research that uses a coding process (Qureshi & Ünlü, 2020). *Open coding* develops a set of codes based on prior theory. Open codes are created to help analyze the content in the photograph. Researchers then attach those codes to the photos as they review them.

Summary

After synthesizing the ideas from the literature across various fields of study, the need for further exploration became evident. Many of the biophilic and environmental studies showed connections between health and habitat. The research indicated that plants could create positive affects for human psychology and health, but the conclusions and implications were less clear. There was a consensus that nature can be helpful for restoration and stress reduction, but little indication of how this plays out on a societal level or affects design trends. Some studies already proposed the use of biophilic aspects in design strategies and argued for putting the user experience at the center of that strategy (Callaghan, 2015; Hwang & Lee, 2018; Vischer 2008). However, these can only remain suggestions while clear relationships have yet to be established. It is evident that the awareness of stress and mental health is on the rise. However, it remains unclear how intervention in the environment can promote health, or if perhaps people respond environmentally to stress in ways they do not notice in the moment. With the history and

philosophy explored, the next chapter discusses how to create variables derived from the literature and use them to evaluate interior design strategies.

Chapter 3

Methodology

The literature demonstrated that biophilia and environmental psychology are relatively new concepts that need more clarity and explanation of underlying mechanisms. This study used a photo-ethnographic approach to look for evidence of biophilia in design choices. As established in chapter two, many studies relied on user input which may have fallen short due to preference bias and small sample size. This project bypassed these limitations by using existing photographic data and social data to compare the historical design with markers of stress in the general population. The research comprised a trend study using content analysis of images in historical design magazines.

Instruments

The instruments of assessment, a count-based rubric created for this study and a photo-ethnographic coding scheme, developed data from photos for use in statistical analysis. The rubric defined which objects from a photograph to include or exclude in the ratio level counts for analysis. The purpose of this process was to develop numerical data to statistically analyze the quantity and type of plant objects in the photographs. The researcher alone developed definitions from relevant literature and codified them to guide data collection. This rubric is included in Appendix A of this document. The definitions emphasized objective qualities of items like color, size, and number. In theory, this

method would lend stronger objectivity to the largely subjective process of analyzing visual content. Other studies would be needed to test the reliability of this method. The method filled the need of turning photographic content into a stricter set of data points to use for statistical comparison with the stress data. The researcher used the rubric to count the number of plants and items with visual plant-characteristics in each photograph. This was the method that analyzed plants and plant-like content in this study. The method for counting plants, which derives criteria from prior literature, is analogous to the open coding process in photo-ethnography. The researcher created codes to evaluate window views after collecting and reviewing the photographs.

Data Collection

The researcher collected screenshots of photographs from PDF editions in the magazines' archives in addition to scans from physical copies at the Stephen F. Austin State University Steen Library. The target sample size of photos to be collected was 400 photographs. The researcher chose the limit of 400 photographs after performing a test run of 10 photographs. With the time allotted for analysis, a target of 400 presented an achievable goal and produced relatively low sampling error. The researcher set the years of consideration as 1965 to 2020 because this was the period with the most overlapping social and magazine data available. Additionally, this period overlaps with the publication of the relevant sociological studies in the literature review thus maintaining appropriate relationships between data. This study comprised a longitudinal examination of the data for this time (1965-2020). The photographic coding data were recorded using

Microsoft Excel and then entered into the IBM Statistical Package for the Social Sciences (SPSS). The researcher entered sociological data from each source in Excel then reformatted them for use in SPSS. The researcher coded the photo data for the photographs based on criteria outlined in this chapter and included in in Appendix A.

Magazine Data

Four design magazines provided photos for data collection. The researcher chose the magazines in this study based on their longevity of publication, high availability of overlapping publication with the stress data, and avoidance of regional content. A longer length of publication meant that more data was available for sampling during the period. Interior designers on the thesis committee approved the magazines for use. The committee also discussed the magazine's popularities and the genre differences between them. Additionally, magazines that ran in the late 20th century are more culturally aligned with the data for stress. The researcher intentionally avoided much older magazines for the purpose of this study because stress literature that helped inform the methodology was not from that time. The culture surrounding stress and its relationship to society might look different in a more distant period. Regional content also presented a problem for the research because natural biomes can affect people's relationship with nature and, by extension, the choices they make (Roetzel, 2020). A magazine for audiences in a forested area might showcase more nature than one that publishes in a drier climate. For this reason, the researcher excluded magazines that had specifically regional content like *Southern Living* and *Coastal Living.*

Genre and Publication Length. Of the interior design magazines for review, four magazines best fit these criteria. These magazines were *House Beautiful*, *Better Homes and Gardens*, *Architectural Digest*, and *Architectural Record*. Among these magazines, *House Beautiful* and *Better Homes and Gardens* contained material aimed at the personal homeowner like budget remodels and do-it-yourself crafts. The *Architectural Digest* often showcased more high-profile homes like those of celebrities and royalty, while *Architectural Record* contained contemporary and commercial architecture. The researcher made these determinations after viewing the content in magazines and discussing with the thesis committee members. This was a perceptual determination on the part of the researcher and not the result of statistical analysis. The researcher intentionally included magazines that showcased personal home design alongside ones that contain high-end and commercial design. These genre differences can show whether parallel differences exist across magazines with diverse publication goals. Future researchers can refer to these differences to see if one type of magazine would be more helpful for their study. After review of these considerations, the researcher determined that pulling photographs from four magazines would be a suitable workload for the study.

There were limitations in using the available data for each magazine. While the dates of available editions for *Architectural Digest* and *Better Homes and Gardens* ran up to the present day, the data sources available for research only had editions for the *Architectural Record* to 2015 and *House Beautiful* to 2001. For this reason, the researcher

made a concerted effort during photo collecting to balance the numbers between the magazine genres – house magazines vs. the contemporary style magazines. This strategy considered *House Beautiful* and *Better Homes and Gardens* as being directed at middle-class homeowners, while *Architectural Digest* and *Architectural Record* were viewed as being for architects and high-budget clients. This was based on the researcher's determinations after viewing the content. The effort to equalize numbers included returning to the sample and resampling previously deleted editions if extra numbers were required. However, this technique was not overly used considering that both genres included one magazine that published to the present day.

Sampling Procedure and Document. The researcher created a spread sheet in Excel to track the total number of magazine editions of that could be accessed through digital or paper copies. This document was laid out with columns representing magazines and rows representing years of publication. The researcher marked each available-to-sample edition with an "x" and left unavailable editions blank. Across all publication histories, this document rendered 1,402 editions for *Architectural Record*, 651 for *Architectural Digest*, 1,186 for *Better Homes and Gardens*, and 990 for *House Beautiful*, comprising a total of 4,229 available editions as of October 25, 2021. Overall, the earliest edition was published in 1891, and the most recent in August of 2021 at the time of sampling. Between the years of 1965 to 2020 there were 2,368 published magazine editions from which the final sample of 390 photographs was derived.

The Excel document also kept track of the sampling procedure used to select which editions to pull and search for photos. To determine magazines issues for consideration, the researcher selected magazines using a *systematic sampling* procedure which selected every fourth edition from each magazine in the period (Babbie, 2015). Every fourth edition in each magazine was highlighted yellow in the spreadsheet to mark it for collection. The researcher offset each magazine's positions in the selection to produce a sample that covered every month in the year, e.g., August from *Architectural Record,* September from *Architectural Digest*, October from *House Beautiful, etc*. After the first round produced an intermittent selection across the entire time frame, the number of available editions was still well over 1,000. A second screening used intermittent deletion to trim the sample size closer to the target of 400. Every third highlighted magazine was deleted. By deleting at these intervals, the researcher narrowed the number of editions to a sample closer to 400 while still maintaining even dispersion throughout the years. These intermittent techniques produced a sample that varies by month and magazine each year.

This sampling also controlled for seasonal months by intentionally shifting the selection and deletion processes to reduce spring and winter editions, where views and content could be affected by seasonal imagery. Once the sampling procedures were complete, the researcher accessed each magazine collection to pull the editions highlighted in the sample document. The researcher reviewed each edition for a suitable photograph based on the criteria in the next section of this chapter. If a suitable photo was

in the magazine, the researcher took screenshots the photograph in online editions, or digitally scanned to record print editions. After the researcher collected a photo from an edition, that edition was highlighted green in the sample document and the "x" changed to a "c" for collected. If the edition did not have a photo that could be used, the researcher highlighted that edition red and marked "o" to note that it was reviewed without collecting any photograph.

Each magazine was examined to see if it contained at least one photo suitable for analysis. If a monthly edition did not meet the listed criteria, the researcher sampled an alternate edition from a nearby month of the same magazine and year. The *Architectural Record* proved an exception to many of these procedures because it ran editions that emphasized houses in April or May of each year. Because their other editions had much less house content, this "Record Houses" edition would often be the backup magazine to sample when another would not work. As such, the *Architectural Record*'s distribution skews higher in these months.

Of the 116 editions of *Architectural Record* that were reviewed, 32 were rejected because they had no suitable photos for analysis; this represents a rejection rate of 38.10%. The second highest rejection number, for comparison, was the Architectural Digest with 10 rejected photos for a rejected rate of 8.93%.

Photographic Content Selection

To choose what kinds of photos would be selected for analysis, the researcher established criteria to choose photos from the magazines. This provided a control

measure for the varied content in magazines. In addition to seasonal variations, the magazines also contained a wide variety of construction types including businesses, schools, churches, and homes. Even more content filled the pages in the form of advertisements and product recommendations. To limit the scope of the examination and provide better clarity in results, the researcher limited photo selection to home interiors only. This study did not consider photos of exterior architecture or commercial design. These criteria also excluded advertisements since most of those photos contained product closeups that did not include full images of a room. Some ads also had content that was clearly anachronistic to the time of publication such as a 1976 advertisement for Pella clad windows that featured a castle built in 1886. For these reasons, analysis included only photos from articles that showcased a home interior.

Room type also determined which photos were selected so that the sample would mostly contain areas like living rooms and other common spaces. The analysis included some dining rooms and kitchens if other content was unavailable, but these were not preferred given that the decorative items this project measures are often restricted in favor of functional space. All but four of the photos in the sample came from homes in the United States. These photos had internal consistency with their magazine of origin and were not wildly different from the other American photos in those editions. The researcher included them and tagged each with the city of origin in their file name.

In total, 442 magazines were analyzed by the researcher to produce 390 photographs suitable for analysis with the coding scheme. These guidelines helped

control for the decision-making processes behind the interior design programming, allowing for the most similar spaces to be compared across the time range. If after the sampling and collecting procedures were met and a photo was still unavailable in a particular year, the researcher collected missing data from an alternate/un-sampled edition of the same magazine and year as close as possible to the same month. These criteria produced the 390 photographs used in the analysis.

Variables

The researcher chose the variables of this study based on a review of the available literature. Scholarship pointed to these variables as the most comprehensive markers of stress from psychological research. The literature also noted the use of plants and plant-like objects as clear markers of biophilia within design contexts.

Independent Variables – Social Variables

Data on hospitalization rates were collected using the National Health Institute Survey (NHIS) data available in PDF form from 1963 to 2021. This study used the rate of hospitalizations per 100 population per year. Hospitalization works well to analyze the health marker of stress because a hospital visit would likely be associated with a sudden stressful change related to the experiential stress mentioned in chapter two.

The United States Census Bureau website provided data on poverty within the United States. The Census site contains several tables of available poverty data for various populations from 1959 to 2020. The second table from the Bureau site contained poverty rates for all persons in the United States. Poverty is calculated in thresholds by

the Census Bureau every year. The Bureau calculates multiple sources of income then compares them to measures for cost of living based on the Consumer Price Index for All Urban Consumers (CPI-U). This gives tables for each year that determine who falls into the poverty thresholds based on income, need, and family size (Bureau, 2021). For example, in 1997 the rate was 13.3 indicating that for every 100 people in the United States 13.3 people were in a calculated poverty threshold.

The Uniform Crime Reporting (UCR) program has collected and generated crime data since 1930. UCR data for violent crime in the United States are publicly available through the Disaster Center, a civic organization run by the Library of Congress. The Disaster Center website listed data from 1960 onward, calculated by crime incident per 100,000 persons per year. Additionally, the Disaster Center had clearer formatting than the UCR website, so the researcher used their system which cited that its original data was pulled from the UCR program. The present study used the rate of violent crime as opposed to all crime. This controlled for instances of property-related crime like burglary or vehicle theft. The violent crime statistic included totals for murder, forcible rape, robbery, and aggravated assault. As an example, in 1997 this number was 611 indicating that for every 100,000 people in the United States 611 crimes were committed in the previously mentioned violent categories. This is in keeping with literature indicating that stress-related crime concerns are more affiliated with violence, not property damage.

Dependent Variables - Biophilic Variables

Drawing from the investigations included in the literature review, one of the most prevalent indicators of biophilia is plants. Studies showed plants have beneficial effects on stress reduction and promoted increases in productivity when present in an office as opposed to a lean office space (Bringslimark, 2009 as cited in Gillis et al. 2015; Larsen et al., 1998). While all studies indicated that there are positive effects to be gained from plants, there are mixed results when it comes to what the effects are. Some observations showed that while comfort and preference could increase with plants, there was no association with productivity.

In addition to the benefits of plants in a room, there was also an intrinsic link between many of the forms in the natural world and a branch of mathematics called fractal geometry (Joye, 2007a). Fractals are curves or geometric figures wherein each part of the structure contains recursive forms that resemble the whole – i.e., magnification into the main shape reveals smaller form that mirror the larger. Most plants have some aspect of this geometry such as trees that repeat their branch pattern as they grow and flowers that spiral their petals and leaves. Research showed that plant forms containing fractal geometry encourage preference over other forms and can dampen stress in certain ranges of geometric complexity (Joye 2007b, Ziabakhsh 2016). Some researchers have theorized that people prefer plant forms in this range because of the way the human visual system developed over time, making it easier to identify the visual characteristics of certain fractals (Taylor et al., 2017). Every proposed biophilic design matrix in the literature

review referenced direct connection with nature as a biophilic aspect (Browning, 2016; Gillis et al., 2015; Ryan et al., 2014). The literature defined direct connection to nature as an immediate visual or tactile interaction between a person and plant material. Due to their prevalence in the literature and ease of identification in photos, this study used number plants and number of plant-like objects as the natural elements for measurement.

Plant Variables. A rubric guided the coding process for each variable. These variables evaluated the number of plants in the photos, the number of plant analogues (defined as any object with plant-like imagery or characteristics), and information for window type and view. Before analysis, the researcher determined to identify plant characteristics including size, coloration, and whether plants were grouped or stand-alone. Coloration defined plants as being fully green, mixed, or having no green coloring at all. Mixed plants included plants like variegated pothos, or flower arrangements that had several colors present either in multi-colored leaves or multiple plants in the arrangement. The researcher determined large plants as being visually estimated at five feet or taller or taking up a visual breadth of approximately three feet like large palms and ficus trees. The small category included plants and flower arrangements smaller than 5 visual feet of height and three visual feet of width.

The researcher also identified plant analogues, and their characteristics including whether the plant analogue was organic or inorganic/stylized. This variable included items such as floral curtains, furniture with carved plant motifs, glass artwork portraying natural imagery, and other objects containing natural imagery. Organic analogues were

items closely resembling a real plant such as a photograph of a nature scene or items with patterns of realistic plant motifs. Inorganic/stylized analogues were items inspired by or related to plants but containing shapes or colors of plants unlikely to be found in real nature such as highly symmetrical or simplified versions of the plant. This scheme focused on room items and excluded architectural features, such as decorative wainscoting or columns, from analysis. These would be more difficult for a homeowner to change and thus may originate outside of the period when the photo was taken.

Each run of this process for a single photo generated multiple counts for plants and plant analogues as well as the characteristics for each counted item. Data also recorded the year of the photo, monthly edition, and magazine of origin. The rubric for analysis and example photographs with highlighted objects are included in Appendices A and C respectively. Using this explicit coding process helped alleviate the subjectivity of the coder. The recorded rubric also ensures the method could easily be replicated by another researcher. The analysis of counted objects for plants and analogues considered only interior items. The window variable assessed exterior vegetation.

Window Variables. Like individual plants and plant items, research showed that the ART and SRT responses can be stimulated by broader visual aspects of nature like views through a window. These studies indicated that views of natural landscapes like greenery are beneficial to the occupants, and they have also shown that fabricated images of lush vibrant scenes could be more restorative than bare trees in winter, or trees among built structures (Felsten, 2009; Ulrich, 1984). This phenomenon also accounted for the

specific intention on the part of the researcher to not attempt the classification of fake plants. Based on the study involving scenes of nature, it is apparent that the biophilic effect is largely visual and does not require actual biological material. While the literature did not mention fake windows, it could be assumed that viewing a natural scene in a fabricated window view would have the same effects as images that portray nature discussed in the literature review. In this case the kind of natural representation would determine the strength of the biophilic effect.

In addition to vegetation, windows offered two other signifiers of the biophilic response. Natural light has been shown to improve mood and concentration for nursing staff as well as help students concentrate in classrooms (Küller & Lindsten, 1992; Zadeh 2014). Better integration of windows brings natural lighting and views into the home which could produce a strong biophilic effect. Windows also are known to increase the prospect of one's position within the room. Out of the theoretical aspects from Appleton and the Kaplans – prospect, refuge, mystery, and complexity – the prospect had the greatest support in scholarship in studies of preference and comfort (Dosen & Ostwald, 2016).

For these reasons, the view from the room’s window was recorded for statistical analysis. This study designated four qualities to code windows: window type, window treatment, window view, and time of day. Window type comprised three attributes: (1) whether a room had standard height windows with the walls (standard), (2) skylight or clerestory type windows (clerestory), or (3) both types were present. Clerestory windows

are placed high on the wall near the ceiling of a room and usually run across the entire length of a wall. This study included traditional clerestory windows and skylights in this category since both would allow light but obstruct views of the surrounding area.

Window treatment was simply whether the window had a treatment applied to the interior structure or not, coded by a yes or no. Window view was the only variable that did not have a set of attributes before collecting the photos. The researcher created attributes for the window variable after viewing the photos during the collection process. These attributes were full green, part green, bare, architectural, and composite (any combination of the previous four views). Full green views had completely green views of nature like a close view of a lush forest, while part green views had some greenery and other natural elements that were not green like rocks or streams. Bare views were natural scenes with no greenery at all, such as the ocean or snow, and architectural views had only built content with no natural elements. These codes along with the plant and item definitions are included in Appendix A.

Figures 1-3 showcase some of the photographs in the analysis. The researcher added contrast to the photos in this document to demonstrate how items were counted in the photographs. Labels differentiate between the plants and analogues counted in each one. The headings for each figure show the name given to the file which include the photo's magazine, year, monthly edition, and page number. These figures show the process of selecting items in photographs using the rubric. Plants have the green labels with prefix "P" while plant-like objects (analogues) have purple labels with prefix "A."

Figure 1

Photograph BHG-1998-09-p196

Figure 2

Photograph AR-1985-04-RH-p75

Figure 3

Photograph AD-2008-03-p177

Figure 1 contains two plants, both of which are mixed, ungrouped, and small. There are three natural analogues. The researcher defined A1 and A3 as organic and A2 as stylized. The researcher made judgements of the quality of organic items based on the level of detail in that item. Because the photo over the mantle presents low-detail representations and relies more on the coloration and form to build the scene, it scored the inorganic qualifier. The photo is from page 196 of the 1998 *Better Homes and Gardens* September issue. The string of data in the Excel document for Figure 1 was as follows: magazine-BHG, month-09, year-1998, crime rate-566.4, rate of hospitalization-8.6, rate of poverty-12.7, total plants-2, green plants-0, mixed plants-0, non-green plants-

0, grouped plants-0, number of groups-0, ungrouped plants-2, large plants-0, small plants-2, total plants size adjusted (times 2)-2, total organic items-5, total organic items size adjusted (times 2)-5, total analogues-3, organic analogues-2, stylized analogues-1, window type-standard, treatment-yes, view-full green, time-day.

Figure 2 is from page 75 of the 1985 *Architectural Record* special "Record Houses" edition in April. It contains one plant that is small, mixed, and ungrouped. The curtain panels counted as four stylized analogues. The string of data in the Excel document for Figure 2 was as follows: magazine-AR, month-04, year-1985, crime rate-556.6, rate of hospitalization-9.2, rate of poverty-14, total plants-1, green plants-0, mixed plants-1, non-green plants-0, grouped plants-0, number of groups-0, ungrouped plants-1, large plants-0, small plants-1, total plants size adjusted (times 2)-1, total organic items-5, total organic items size adjusted (times 2)-5, total analogues-4, organic analogues-0, stylized analogues-4, window type-both, treatment-yes, view-composite, time-day.

Figure 3, located on page 177 of the 2008 March edition of *Architectural Digest* has three plants and no organic analogues. Two of the plants are green and one is mixed. All were ungrouped. Using the rubric, the researcher classified P1 as a large plant and the other two as small. The string of data in the Excel document for Figure 3 was as follows: magazine-AD, month-03, year-2008, crime rate-457.5, rate of hospitalization-8, rate of poverty-13.2, total plants-3, green plants-2, mixed plants-1, non-green plants-0, grouped plants-0, number of groups-0, ungrouped plants-3, large plants-1, small plants-2, total plants size adjusted (times 2)-4, total organic items-3, total organic items size adjusted

(times 2)-4, total analogues-0, organic analogues-0, stylized analogues-0, window type-both, treatment-yes, view-full green, time-day.

The researcher made all these entries into the Excel sheet that listed each photo and contained columns for each individual piece of data. Statistical analysis compared the photographic data to the sociological data for the period.

Data Analysis

The IBM Statistical Package for the Social Sciences (SPSS) Version 28 calculated the statistical procedures used for analysis (IBM Corp, 2021). Standard descriptive statistics for the collected variables examined potential issues of multi-collinearity as well as other patterns among the independent variables. At this point, no variable was so skewed to be labeled as unfit for analysis. This study determined levels of significances at the .05 level. The Szafran model assigned strength of relationship according to Szafran's statistical textbook (Szafran, 2012, p. 199). Standard data cleaning techniques evaluated missing or outlier data. The only variables that contained missing data were the window variables. Cases with missing window data indicate when a window was not present in a room or when the view from a window was not distinguishable enough to be categorized. After SPSS generated initial descriptive statistics, bivariate analysis looked for patterns between variables and created visualizations of data. Lastly, an investigation of multivariate statistical procedures targeted each of the research questions listed in the next section.

Research Questions

The primary focus of this study was to compare societal stress with the amount and type of natural imagery in the home. Based on the research objectives and literature consideration, the researcher generated the following questions to guide the investigation.

1. What kind of relationship, if any, exists between levels of stress in society and the use of plants in the home?
2. What kind of relationship, if any, exists between levels of stress in society and the use of plant-like objects in the home?
3. What kind of relationship, if any, exists between levels of stress in society and the types of views from windows?

Conclusion

These methods have been derived from the research on biophilia and social stress. The intention here was not to prove beyond doubt that the paradigms of biophilia exist, but rather to explore their connections with human psychology and find new ways of evaluating design. If the theories here should inspire some new way of looking at art and its representation, then the goal to participate in the scholarship will have been accomplished; and if, on the contrary, the ideas here should prove inconsequential and without correlation, then the rationale must be sought elsewhere, and the same goal has still been met.

Chapter 4

Results

Magazine Data

A total of 442 magazines created a sample of 390 photographs. The collection contained exclusively photos of interiors, with nearly all pictures comprising living or social spaces. Table 1 depicts the counts and percent for each magazine's contribution to the sample.

Table 1

Number of Photos by Magazine of Origin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Architectural Digest	113	29.0	29.0	29.0
	Architectural Record	84	21.5	21.5	50.5
	Better Homes and Gardens	116	29.7	29.7	80.3
	House Beautiful	77	19.7	19.7	100.0
	Total	390	100.0	100.0	

The magazine variable contained four attributes: *Architectural Digest*, *Architectural Record*, *Better Homes and Gardens*, and *House Beautiful*. *Architectural Digest* provided 29.0% of the photographs, *Architectural Record* had 21.5%, *Better Homes and Gardens* had 29.7% and *House Beautiful* had 19.7%. Editorial decisions from the magazines created limitations that made it difficult to sample the same number from each magazine. These limitations included seasonal variations in content as well as

differences in the number of residential photographs available per magazine. By sampling similar amounts from both genre types of magazines, the photos are divided almost in half by the similar content groupings – 50.5% between *Architectural Digest* and *Architectural Record*, and 49.5% between *Better Homes and Gardens* and *House Beautiful*.

Table 2 contains the number of magazine photos by month. The highest frequency was in April with 47 editions, comprising 12.1% of the total count. The smallest was March contributing only 3.8% of the sample. A likely reason for this disparity is housing specific issues of the *Architectural Record.*

Table 2

Photo Counts by Month

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	January	28	7.2	7.2	7.2
	February	28	7.2	7.2	14.4
	March	15	3.8	3.8	18.2
	April	47	12.1	12.1	30.3
	May	43	11.0	11.0	41.3
	June	35	9.0	9.0	50.3
	July	35	9.0	9.0	59.2
	August	35	9.0	9.0	68.2
	September	38	9.7	9.7	77.9
	October	35	9.0	9.0	86.9
	November	35	9.0	9.0	95.9
	December	16	4.1	4.1	100.0
	Total	390	100.0	100.0	

The plan to reduce seasonal editions in spring was successful; however, certain editorial choices, primarily from the *Architectural Record*, affected these editions. Once a year it ran a special edition that showcased only homes. The magazine always released these editions in April or May, while the rest of their yearly catalog contained mostly public and commercial use architecture. Their largely commercial focus rendered much of the *Architectural Record*'s catalog unsuitable for use having no home photos at all. Because of this, the researcher sampled most of the alternate photographs from the April/May editions. This phenomenon explains the skews of the overall April and May counts to higher numbers.

The December issues of several magazines also skewed numbers in the sampling process, due to the heightened holiday content. Most December pictures contained decorative greenery that would not typically be present and therefore these photos were not included. This information pinpoints two key findings for future researchers conducting similar studies: 1) magazines like *Architectural Record* need special attention given to the counts and conclusions because of the way they create specialized editions, and 2) effects to curb seasonal variation might be better if approached by context and purpose of items rather than just seasonal timing of magazine editions.

The crosstabulation in Table 3 displays the counts and percent for each magazine, listed by month of publication and magazine of origin. Table 3 makes it easier to determine which, if any, magazines might affect conclusions about the month variable. For instance, an imprecise reading of the data might suggest that certain months such as

April and May displayed fewer plants during the year. However, this argument is flawed because the spring contains mostly photographs from *Architectural Record* which have demonstrably fewer plants per photo overall.

The counts show how the intermittent sampling of the data creates certain peaks during different times of year for different magazines. There was a significant relationship between the monthly editions and the magazine of origin ($\chi^2 = 194.118$, df = 33, $p < .001$). The strength of relationship was strong (Cramers V = .407). Due to the sampling procedure, different magazines have higher numbers in certain months. This data should not be used to describe trends within months or seasons without first adjusting the variables to account for uneven distributions over the months. Figures B1-B4 in the supplemental figures index represent the Table 3 data visually in bar charts representing each magazine.

Table 3

Monthly Editions of Magazines by Magazine of origin Crosstabulation

			Magazine of origin				
			AD	AR	BHG	HB	Total
Monthly Edition of the Magazine	January	Count	6	6	14	2	28
		%	5.3%	7.1%	12.1%	2.6%	7.2%
	February	Count	15	4	4	5	28
		%	13.3%	4.8%	3.4%	6.5%	7.2%
	March	Count	3	0	9	3	15
		%	2.7%	0.0%	7.8%	3.9%	3.8%
	April	Count	2	32	7	6	47
		%	1.8%	38.1%	6.0%	7.8%	12.1%
	May	Count	15	19	8	1	43
		%	13.3%	22.6%	6.9%	1.3%	11.0%
	June	Count	20	0	4	11	35
		%	17.7%	0.0%	3.4%	14.3%	9.0%
	July	Count	11	0	15	9	35
		%	9.7%	0.0%	12.9%	11.7%	9.0%
	August	Count	3	4	21	7	35
		%	2.7%	4.8%	18.1%	9.1%	9.0%
	September	Count	12	13	10	3	38
		%	10.6%	15.5%	8.6%	3.9%	9.7%
	October	Count	14	2	9	10	35
		%	12.4%	2.4%	7.8%	13.0%	9.0%
	November	Count	4	2	13	16	35
		%	3.5%	2.4%	11.2%	20.8%	9.0%
	December	Count	8	2	2	4	16
		%	7.1%	2.4%	1.7%	5.2%	4.1%
Total		Count	113	84	116	77	390
		%	100.0%	100.0%	100.0%	100.0%	100.0%

The monthly spikes created by intermittent sampling can be observed in Table 3 where the numbers rise and fall rather than remain even across the months. *Architectural Digest* has a higher concentration of cases around June and October. *Better Homes and Gardens* has this spike in August, and *House Beautiful* has it in November. *Architectural Record* has the highest spike of any magazine in April with a second high spike in May. This reflects the *Architectural Record*'s house-specific editions in those months

Social Data

Table 4 gives the statistics for each of the social variables used in the analysis. Figures 4-6 plot these variables by year of magazine. The rate of violent crimes has the largest standard deviation of any variable since it was reported by 100,000 population whereas the other variables reported data per 100 persons. Female hospitalization outpaces male hospitalization each time likely due to the inclusion of hospitalizations resultant from pregnancies. The researcher chose not to filter out pregnancies in the analysis because there are no strong reasons why pregnancy would be any less stressful than other types of hospitalization. The average rate of violent crime per 100,000 persons was 500.276. The average number of persons below the poverty level was 13.231. The average of all persons with one or more hospital visits in a year per 100 was 8.861.

Table 4

Descriptive Statistics of Social Variables

		Rate of poverty level (per 100 people)	Rate of violent crimes in Year of photo (Per 100,000 people)	Rate of all hospital visits (per 100 people)	Rate of male hospital visits (per 100 people)	Rate of females hospital visits (per 100 people)
N	Valid	387	383	360	360	360
	Not Available	3	7	30	30	30
Mean		13.231	500.276	8.861	7.221	10.437
Median		13.000	494.400	8.500	6.900	10.000
Std. Deviation		1.3685	137.3461	1.196	.948	1.418
Range		6.8	557.9	3.70	2.90	4.70
Minimum		10.5	200.2	7.00	5.90	8.00
Maximum		17.3	758.1	10.70	8.80	12.70

The Pearson's r for poverty and hospitalization is -.377 as given in Table 5. This relationship is moderate and negative indicating that when poverty rates are higher, hospitalization rates are generally lower and vice-versa. It is also interesting to note that on the graph, the rate of poverty has much steeper changes than rates of hospitalization. This could be an indication that poverty is a more volatile variable, while hospitalization rates do not change nearly as dramatically.

Figure 4

Hospital Visits and Poverty Levels by Year of Photo

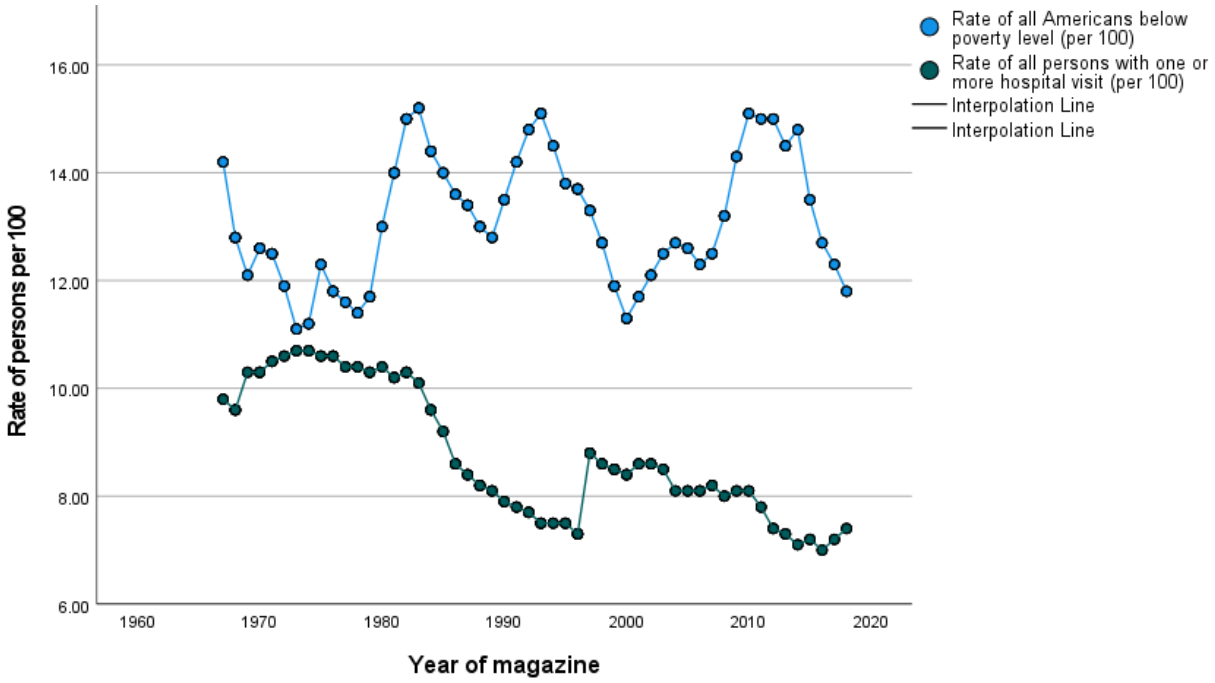


Figure 5 divides the hospitalization statistic into males and females. In the mid-1990s, there was a shift in the way the health data were recorded. The NHIS revised survey questionnaires and went through a transitional period of data collection in 1997. This likely accounts for the jump in available hospitalization data from 1996 to 1997, evident in Figures 4 and 5. In the divided graph, male-female curves clearly mirror each other. This indicates that the factors affecting differences between rates of female and male hospitalization, most likely pregnancy, remain consistent throughout all periods of data collection. While the overall health trends show a decline in rates of hospitalization over time, it is unlikely this is caused by the use of plants in the home because plant

numbers oscillate more consistently, shown in Figure 8. The more likely scenario is that overall quality of health is on the rise due to increases in safety measures and health practices such as building codes and medicinal advancements, as discussed in the literature review.

Figure 5

Hospitalizations by Year of Photo Separated by Sex

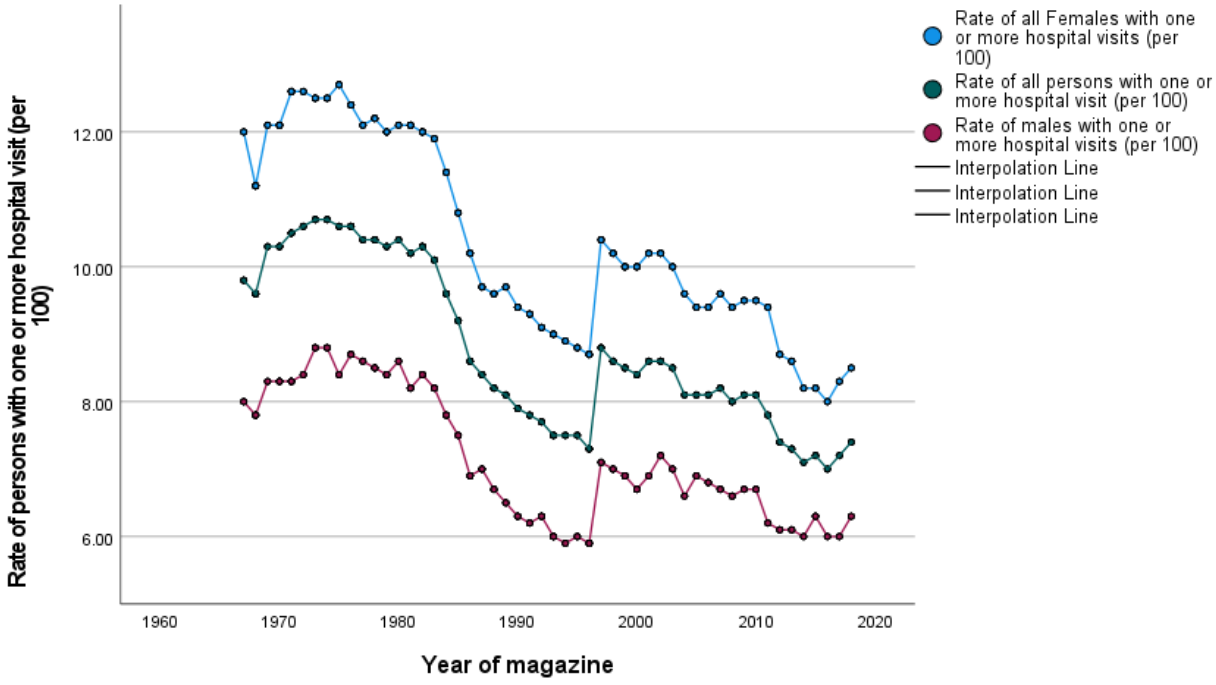


Figure 6 shows the rate of violent crimes per 100,000 persons by year. There is a clear rise in the rates from 1960 to 1990 followed by a steady decline in the years following. While there is not an immediate connection to plants, it is interesting to note that contemporary research about violence has also noted this dramatic curve. Lead levels in the air have been shown to affect the rate of crime across American counties and the

effect is more strongly connected to violent crime rates as opposed to property crime. Data also show that higher resource deprivation including access to healthcare can "aggravate the potential effect of air-lead on crime" while lesser economic deprivation could mitigate the effect (Stretesky & Lynch, 2004). The United States government began phasing out leaded gasoline in the mid-1970s and on January 1, 1996, lead was banned completely by the Clean Air Act (Clean Air Act, 1996). Researchers have shown that some plants can pull the lead out of soil and water (Mani et al. 2015, Singh et al. 2012). This could be another avenue of research for a connection between plants and levels of crime in an area.

Figure 6

Rate of Violent Crime by Year of Photo

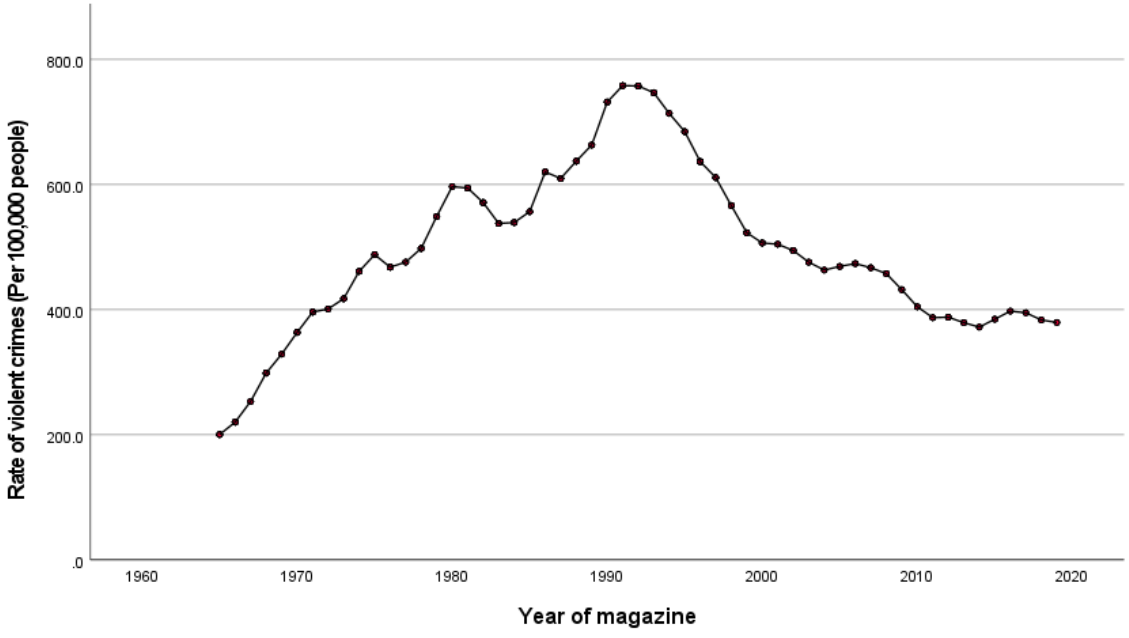


Table 5 lists the correlations between social variables and plant variables. Bold text indicates the significant correlations. The correlation matrix displays the social variables regressed on the number of total plants to examine their effects and look for issues of multi-collinearity. The greatest absolute value Pearson Correlation among the three independent variables, excluding for a moment the plant connections, is between poverty and hospitalization (r = -.377). This indicates that when poverty levels are higher, the number of hospitalizations is lower and vice versa. There is also a moderate, positive correlation between poverty and crime which supports the idea in scholarship that poverty and crime are intrinsically connected in society (Hsieh & Pugh, 1993).

Table 5

Correlations of Total Plants and Social Variables

		Total plants	Rate of violent crimes	Rate of hospitalization	Rate of poverty
Pearson Correlation	Total plants	1.000	.027	**.390**	**-.123**
	Rate of violent crimes	.027	1.000	**-.295**	**.317**
	Rate of hospitalization	**.390**	**-.295**	1.000	**-.377**
	Rate of poverty	**-.123**	**.317**	**-.377**	1.000
Sig. (1-tailed)	Total Plants	.	.307	<.001	.010
	Rate of violent crimes	.307	.	.000	.000
	Rate of hospitalization	.000	.000	.	.000
	Rate of poverty	.010	.000	.000	.

Regarding the plant relationships, the lowest overall correlation is between violent crime and plants (r = .027) which is a positive, weak correlation. This may be explained by the fact that crime is a more impersonal, societal stressor, as opposed to hospitalization or poverty. The literature showed that crime was a concern people had about society while health and finance were concerns people had about themselves.

The relationship between poverty and plants is stronger than crime (r = -.123), though still weak, and indicates a negative relationship such that when rates of poverty are higher the rate of plant use is lower. This last connection is notable considering that the literature indicated that people could use plants to relieve stress. However, because this study measures the use of plants in the home rather than exposure to landscape nature, there is an implied cost for the ability to place and maintain plants in the home. People cannot rely on the beneficial effects of plants to relieve the stress of poverty if they cannot afford them. This could explain the weaker relationship between the two variables. Among the plant/social correlations, only hospitalization and poverty returned with significant relationships with hospitalization having the strongest correlation (r = .390).

During the investigation, the researcher also collected data on the approximate size of plants in the pictures. These data control for the amount of visual greenery in the room. Because this study relied on a baseline of counted objects, it might have misrepresented cases where a small table flower and a large standing palm in a room would both be counted as one plant. An additional variable for plant counts multiplied all

the large plants by two and added them back into the total number. When comparing this new variable to the hospitalization statistic, the Pearson correlation (r = .428) returned as statistically significant. Under the Szafran model, this relationship is strong and positive. This increase in relationship strength presents a good indication that finding ways to measure apparent size of an object could help aid future study.

Item Data – Plants, Analogues, and Windows

This section contains the frequencies and means for all items counted in the study. Tables 6 and 7 contain the frequency of photos by the number of plants while Tables 8 and 9 give the breakdown of organic analogues. Table 10 contains the sum total of all items together, and Table 11 reports the descriptive statistics for all items counted in the tables.

Plant Data

Table 6 shows the number of photos listed by the count of all plant types in a photograph. Most photographs (72.3%) had between one and four plants while (9.5%) had none. Numerous photos were missing at least one of the three types of plants collected in the data. Table 6 indicates that the largest percentage of photos (22.3%) were those having two plants in the room. This is followed closely by rooms having only one plant, making up 20.26% of rooms. The mean number of plants in a photo was 2.93 (SD = 2.44) and the median number of plants was 2. Table 6 is useful in establishing a baseline for what can be considered a common number of plants by room. The means

demonstrated that the most common number of plants in a room was two while the portion of rooms with more than 6 plants comprised only 7% of all rooms examined.

Table 6

Frequency of Photos by Number of all Plants Counted in a Photo

			Frequency of photos	Percent	Valid Percent	Cumulative Percent
Number of all plants	Valid	0	37	9.5	9.5	9.5
		1	79	20.3	20.3	29.7
		2	87	22.3	22.3	52.1
		3	66	16.9	16.9	69.0
		4	50	12.8	12.8	81.8
		5	27	6.9	6.9	88.7
		6	16	4.1	4.1	92.8
		7	7	1.8	1.8	94.6
		8	8	2.1	2.1	96.7
		9	5	1.3	1.3	97.9
		10	2	.5	.5	98.5
		11	2	.5	.5	99.0
		13	2	.5	.5	99.5
		16	1	.3	.3	99.7
		17	1	.3	.3	100.0
		Total	390	100.0	100.0	

Table 7 shows a breakdown of the plant totals divided into the plant type categories: green, part-green, and non-green. This table shows that zero is the modal number for each specified plant category. The zero attribute in Table 6 is much smaller than those given in Table 7. This indicates that while most photos had at least one plant in

the room, most rooms did not contain all three kinds of plants. Pie charts in Appendix B reflect the data from tables 6 and 7 visually.

Table 7 clearly reflects the prevalence of certain plants over others. The zero attributes from each plant type show that in general, the category least likely to be missing in a room was green plants, while the one most likely missing was non-green. The sums of all plants counted corroborate this idea; in total, 587 green plants were counted in the study in addition to 373 mixed plants and 181 non-green plants. The most popular plants in the home were those with leafy green composition and no added color element. This can be seen as support for the idea in the literature that people seek the biophilic effect from green plants and by extension plants that seem most plant-like, i.e. the way they believe a natural image should look (Felsten, 2009; Ulrich, 1984). This does not discount that biophilia could still be triggered by other kinds of plants, but it indicates that plant use in the culture has a preference for leafy green imagery.

Table 7

Frequency of Photos by Type of Plant and Number Counted in a Photo

			Frequency of photos	Percent	Valid Percent	Cumulative Percent
Number of green plants	Valid	0	147	37.7	37.7	37.7
		1	101	25.9	25.9	63.6
		2	55	14.1	14.1	77.7
		3	37	9.5	9.5	87.2
		4	20	5.1	5.1	92.3
		5	13	3.3	3.3	95.6
		6	11	2.8	2.8	98.5
		7	3	.8	.8	99.2
		10	2	.5	.5	99.7
		13	1	.3	.3	100.0
		Total	390	100.0	100.0	
Number of mixed plants	Valid	0	169	43.3	43.3	43.3
		1	128	32.8	32.8	76.2
		2	63	16.2	16.2	92.3
		3	15	3.8	3.8	96.2
		4	9	2.3	2.3	98.5
		5	3	.8	.8	99.2
		6	1	.3	.3	99.5
		7	1	.3	.3	99.7
		10	1	.3	.3	100.0
		Total	390	100.0	100.0	
Number of non-green plants	Valid	0	258	66.2	66.2	66.2
		1	93	23.8	23.8	90.0
		2	31	7.9	7.9	97.9
		3	6	1.5	1.5	99.5
		4	2	.5	.5	100.0
		Total	390	100.0	100.0	

Analogue Data

Tables 8 and 9 report the breakdowns for the number of plant analogues in rooms. Like the individual plant types, the largest attribute in each of these tables was the number of rooms that have no items present (53.3%). The mean number of organic analogues in a photo was 1.23 (SD = 1.91) and the median was zero. In each table, this attribute makes up over half of the sample. Appendix B contains these numbers reflected visually as pie charts.

Table 8

Frequency of Photos by Number of Plant analogues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	205	53.3	53.3	53.3
	1	71	18.2	18.2	71.5
	2	39	10.0	10.0	81.5
	3	30	7.7	7.7	89.2
	4	15	3.8	3.8	93.1
	5	10	2.6	2.6	95.6
	6	6	1.5	1.5	97.2
	7	2	.5	.5	97.7
	8	6	1.5	1.5	99.2
	10	2	.5	.5	99.7
	11	1	.3	.3	100.0
	Total	390	100.0	100.0	

Tables 6 and 8 demonstrate that there was a higher frequency of plant use than the use of analogues. This follows logically considering that plants might be easier and less expensive to put in a room than larger decorative furniture pieces. It could also be

resultant from the method of item counting which excluded interior structural components like moldings and decorated columns. This study also did not include wall paneling, papering, or molding in analysis. A separate study that considered only structural elements in the context of historical development might be more useful in determining how plants apply to structural components. Such a study may also make greater use of external architectural elements which were not included in this study.

Table 9

Frequency of Photos by Type of Analogue and Number Counted in a Photo

			Frequency of photos	Percent	Valid Percent	Cumulative Percent
Organic analogues in a photo	Valid	0	298	76.4	76.4	76.4
		1	40	10.3	10.3	86.7
		2	22	5.6	5.6	92.3
		3	11	2.8	2.8	95.1
		4	9	2.3	2.3	97.4
		5	4	1.0	1.0	98.5
		6	3	.8	.8	99.2
		7	1	.3	.3	99.5
		8	2	.5	.5	100.0
		Total	390	100.0	100.0	
Stylized Analogues in a Photo	Valid	0	251	64.4	64.4	64.4
		1	71	18.2	18.2	82.6
		2	36	9.2	9.2	91.8
		3	20	5.1	5.1	96.9
		4	6	1.5	1.5	98.5
		5	3	.8	.8	99.2
		7	2	.5	.5	99.7
		8	1	.3	.3	100.0
		Total	390	100.0	100.0	

Table 10 compares all plants and analogues added together in the rooms and displays that higher item totals have much smaller frequency, emphasizing the rarity of rooms with large numbers of plants and analogues. The percentages show that 68.2% of rooms had between one and five items with the largest category in that group being rooms with only two items (16.4%). The number of items in a photo ranged from zero to 19. Rooms with no items at all made up 8.2%, and the smallest categories overall were rooms in the range of six or more items – 24.6% of the total. The mean number of organic items in a room was 4.15 (SD = 3.4) and the median was 4. Overall, the data show that most rooms will contain some form of natural imagery and having no natural items in a room was rare.

Table 10

Total Number of Organic Items in a Photo (Sum of all Plants and Analogues)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	32	8.2	8.2	8.2
	1	46	11.8	11.8	20.0
	2	64	16.4	16.4	36.4
	3	51	13.1	13.1	49.5
	4	63	16.2	16.2	65.6
	5	42	10.8	10.8	76.4
	6	25	6.4	6.4	82.8
	7	12	3.1	3.1	85.9
	8	16	4.1	4.1	90.0
	9	7	1.8	1.8	91.8
	10	6	1.5	1.5	93.3
	11	10	2.6	2.6	95.9
	12	2	.5	.5	96.4
	13	4	1.0	1.0	97.4
	14	4	1.0	1.0	98.5
	16	1	.3	.3	98.7
	17	4	1.0	1.0	99.7
	19	1	.3	.3	100.0
	Total	390	100.0	100.0	

Table 11 shows descriptive statistics for each of the counted variables: plants, analogues, and their breakdowns into types. The highest mean for plant types belonged to green plants with 1.51 (SD=2.45), and the highest among plant analogues was for stylized analogues with 0.68 (SD=1.19).

Table 11

Descriptive Statistics of Item Variables

	All plants	Green plants	Mixed plants	Non-green plants	Organic items (sum of plants and analogues)	Plant analogues	Organic analogues	Stylized analogues
Mean	2.93	1.51	.96	.46	4.15	1.23	.55	.68
N	390	390	390	390	390	390	390	390
Std. Deviation	2.44	1.85	1.20	.75	3.40	1.91	1.28	1.19
Median	2.00	1.00	1.00	.00	4.00	.00	.00	.00

By comparing the means of individual categories as parts of the whole, this data could generate percentages for how much each category contributed to the total. The mean number for all plants counted was 2.93 (SD = 2.5). The median for all plants was 2. The mean for plant analogues was 1.23. Green plants made up 51.7% of all observed plants while mixed plants made up 32.8% and non-green plants made up 15.5%. These percentages also mirror the data for total counts in Table 7 which support the idea in the literature that people may seek a stronger biophilic effect from leafy green plants in their personal spaces.

Window Data

Tables 12-15 list frequencies for the four window variables. Table 12 lists frequencies of window type, Table 13 lists whether a treatment was applied to the window, Table 14 gives the time of day the photograph was taken, and Table 15 lists the frequencies for the view from the window. Precise definitions for these attributes and

how they are applied in the coding process are given in Chapter 3 and the code rubric in Appendix A.

Table 12

Type of Windows in the Photo

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Standard	243	62.3	63.0	63.0
	Clerestory	2	.5	.5	63.5
	Both	141	36.2	36.5	100.0
	Total	386	99.0	100.0	
Missing	Unobservable	4	1.0		
Total		390	100.0		

Type of window refers to a window's position in the room. The coding scheme defined "clerestory" as a window above the eye line, usually a line of windows at the ceiling or a skylight. Only two rooms (0.5%) out of all 390 used only this type of window. This was not surprising considering the photo selection process prioritized rooms that had a window view and a clerestory type window would afford no view of the landscape. Another reason this may be uncommon is that this type of window fell out of fashion after the mid-century period. The unfashionability of the clerestory type could also explain why the "both" attribute was smaller than that of traditional windows. The most prevalent window type was a standard window that stayed level with the line of sight on the wall.

Table 13 depicts if window treatments were applied to the interior of the windows. Window treatments included curtains, blinds, shades, or any other application

that could obscure the view of the exterior. The numbers of windows with and without treatment were nearly equal – 51.6% having treatments and 48.4% without. The time of day, as listed in Table 14, was judged by the researcher based on the amount of light in the window frame and the approximate coloration of the scene.

Table 13

Whether the Window has Treatment Applied to it

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	199	51.0	51.6	51.6
	No	187	47.9	48.4	100.0
	Total	386	99.0	100.0	
Missing	Unobservable	4	1.0		
Total		390	100.0		

Table 14

Time of Day When the Photo was Taken

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Day	365	93.6	94.6	94.6
	Night	21	5.4	5.4	100.0
	Total	386	99.0	100.0	
Missing	Unobservable	4	1.0		
Total		390	100.0		

Table 15 contains the window attributes that were generated after collecting the photos for analysis. Based on observation of window views, the researcher determined that these five attributes for windows would be the most comprehensive way to include all window views. Figure 7 shows the percentages for each. Overall, the four variables

represented by Tables 12-15 are the only dependent variables in the study with missing data since the windows were not a controllable factor in the study. Cases that had missing data were given a value of 0 during the coding process and were labeled as "unobservable" in the tables. Most of the window variables had at least four missing cases indicating the four rooms in the collection had no structural window to evaluate for position or treatment. The variable with the highest number of missing cases was Window View. These 93 pictures were of rooms that had a window view obscured by a window treatment or were unidentifiable in the photograph. These missing views made up 23.8% of photos.

Table 15

View from the Window

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Full Green	115	29.5	38.7	38.7
	Part Green	23	5.9	7.7	46.5
	Bare	12	3.1	4.0	50.5
	Architectural	26	6.7	8.8	59.3
	Composite	121	31.0	40.7	100.0
	Total	297	76.2	100.0	
Missing	Unobservable	93	23.8		
Total		390	100.0		

Figure 7

View from the Window

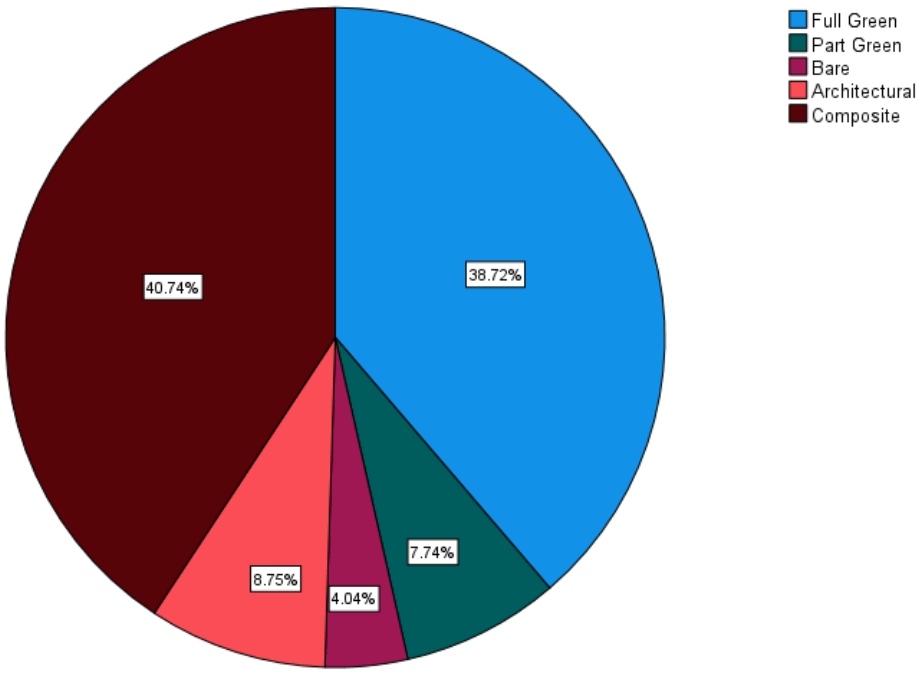


Table 15 lists composite views as being the most common making 40.7% of the valid cases. The next most common was a full green view with 38.7% of photos. All other categories made up less than 9% of the valid photographs. The magazines mostly contained photos that were taken during the day – 94.6% of valid cases – while night photos only accounted for 5.4% of all photos. The visualizations for these data are represented in the pie charts in Figure 7 and the supplemental charts in Appendix B.

Scatterplots and Means

The scatterplots in Figures 8-10 show the distribution of plants, plant analogues, and total organic items by year of the magazine. Table 11 records the mean for all plants

(M = 2.92, SD = 2.45) as well as means for plant analogues (M = 0.55, SD = 1.91), and all organic items (M = 4.15, SD = 3.40). The researcher applied Loess regression lines to each plot to give the approximate trend over time for each variable. The first graph shows that the total number of plants in a room increased slightly in the 1980s then fell towards 2000 followed by an upward trend around 2020. This pattern is echoed, though more subtle, by the graph depicting only plant analogues. Figure 10 gives the total number of organic items in a photo and demonstrates a stronger curve than Figure 8 and 9. The fit lines in Figures 8 and 9 resemble each other, revealing that the use of plants is mirrored by the natural analogues. There does not seem to be any time in which people are engaging in increased use of one without the other. The Loess line for all three approximates a sine wave, which indicates the cyclic nature of each trend over time.

Figure 8

Scatter Plot of all Plants Counted in a Photo by Year of Photo

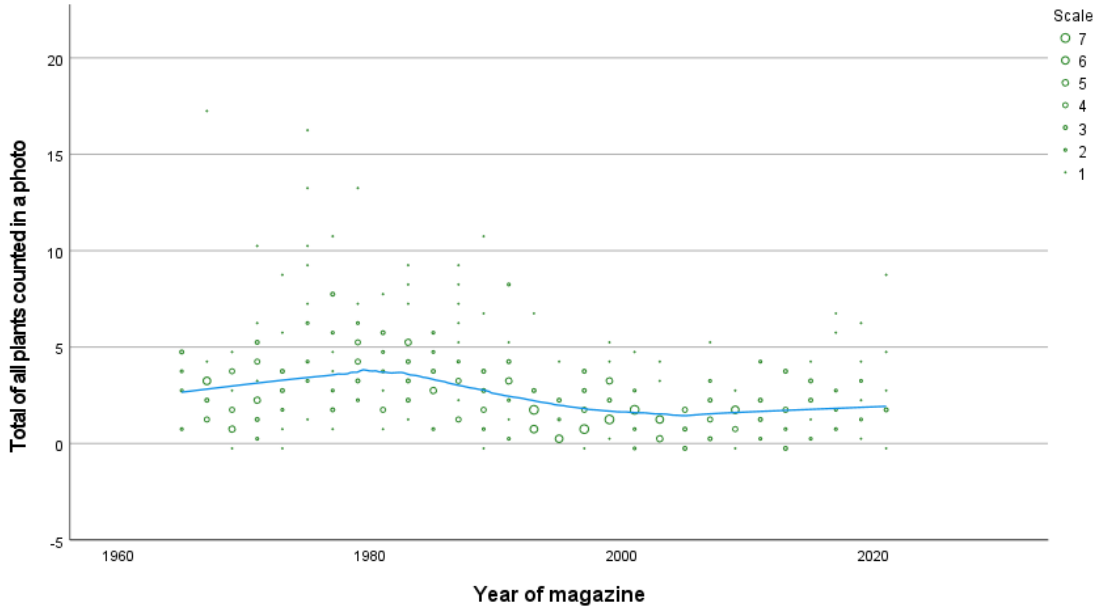


Figure 9

Scatter Plot of all Plant Analogues by Year of Photo

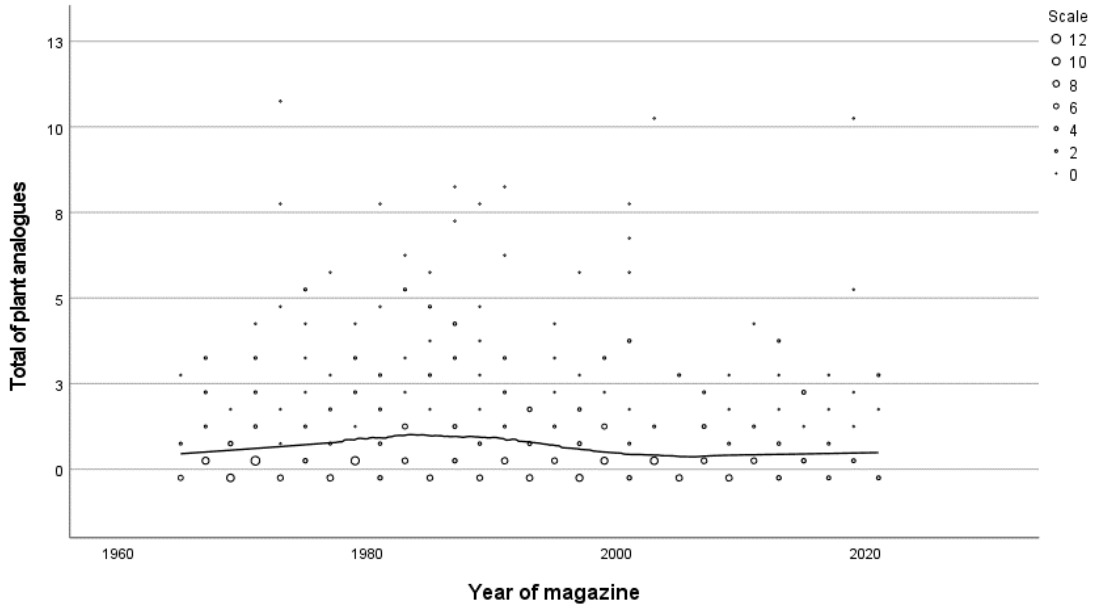
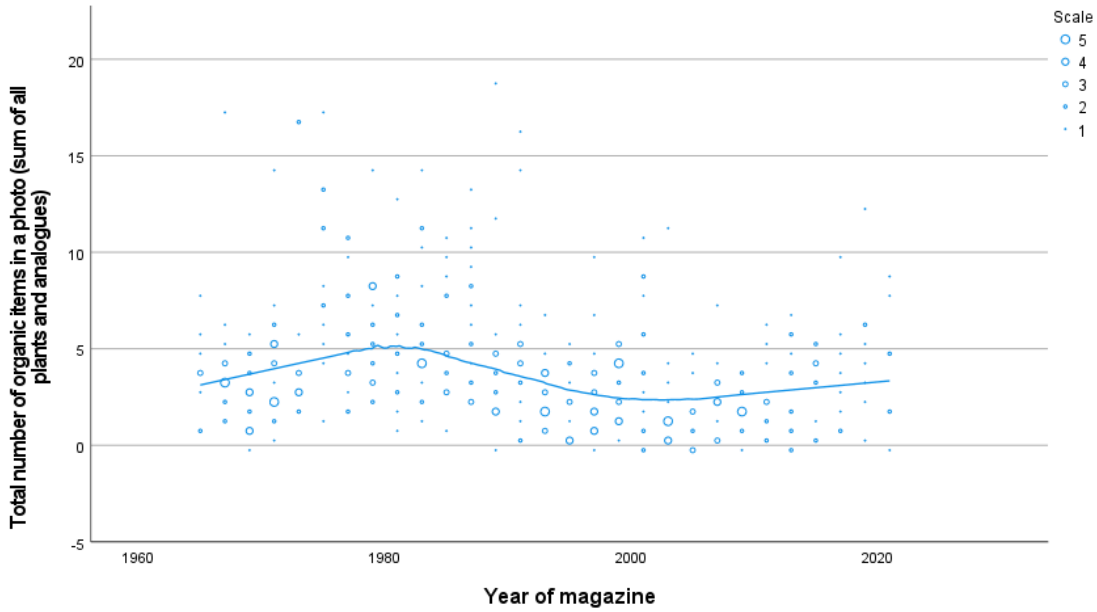


Figure 10

Scatter Plot of all Organic Items in a Photo by Year of Photo



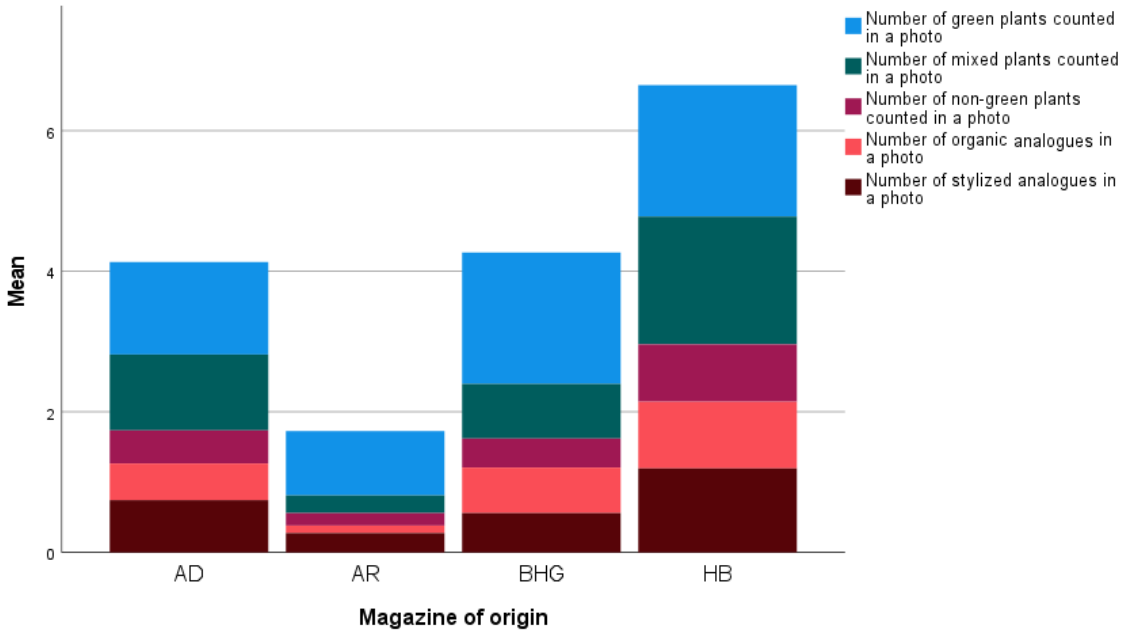
A variable for items by decade grouped the yearly totals into ten-year periods during the larger time frame. This variable excluded years from 1965 to 1969. ANOVA by decade shows that there is a significant effect on mean differences for the total number of items by decade ($F = 10.804$, $df = 6$ and 383, $p < .001$). The highest decade mean for all organic items was the 1970s ($M = 5.77$, $SD = 3.93$) followed closely by the 1980s ($M = 5.68$, $SD = 3.60$). The lowest decade mean for items was the 2000s ($M = 2.60$, $SD = 2.68$). The scatterplots contain insight to the nature of design over long periods. These plots show rolling trends from decade to decade. Even though outlier rooms are present, the scatter plots show how the heavier frequency of photos usually falls within one

standard deviation of the regression lines: SD = 2.4 for plants, SD = 1.9 for analogues, and SD = 3.4 for all counted items.

Figures 11 and 12 visually report means for the different types of items in the photos. Figure 11 shows these totals by magazine and Figure 12 shows the number by monthly edition. Figure 11 shows that while the breakdown of items is proportionally similar in each magazine – i.e., most show green plants as a larger category and most have non-green as a smaller number – there is a large difference in the overall number of items as represented by the total height of each bar.

Figure 11

Mean Breakdown of Item Types in a Photo by Magazine of Origin



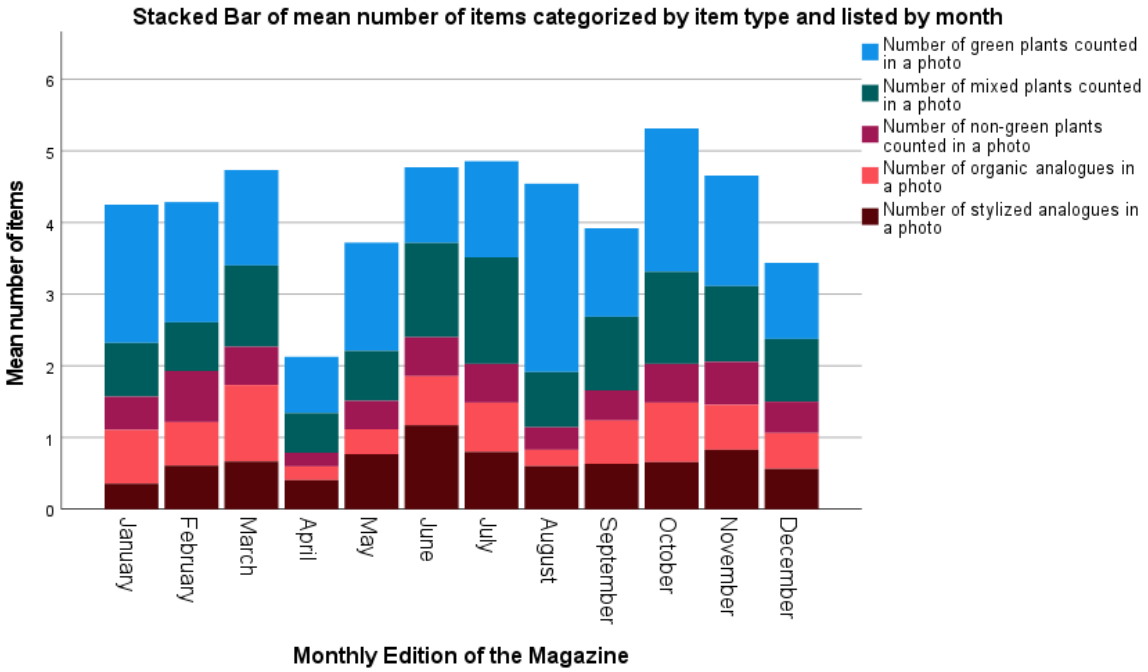
There were significant differences in the means of items counted in each magazine ($F = 35.559$, $df = 3$ and 386, $p < .001$). These results indicate that the editorial

decisions of the magazine creators influenced the way that plants were represented. While the Pearson correlations do show a relationship between variables like plants and hospitalization, the results by magazine indicate caution should be taken when creating generalizations about how people live. This is the nature of using variables that potentially have multiple cause/effect relationships. Future studies may benefit from using denser photographic counts from a single magazine rather than splitting analysis between several publications.

Figures 11 and 12 also help visually represent the issue of magazines affecting the month variable as noted from Table 3. The average breakdown of items in each month closely resembles the magazine that contributed the most editions to that month. Figure 12 shows how April had far fewer plants by publication than other months, but April has a greater percentage of *Architectural Record*'s catalog. The *Architectural Record* averaged about 1.73 items per photo (SD = 1.78), while *Architectural Digest* and *Better Homes and Gardens* had 4.13 (SD = 3.08) and 4.27 (SD = 2.47), respectively. *House Beautiful* averages the highest (M = 6.65, SD = 4.45). ANOVA for the monthly variables shows that there is a significant effect of the monthly editions on item counts ($F = 2.591$, $df = 11$ and 378, $p = .003$). *House Beautiful* on average had rooms with more plants and natural analogues, while the *Architectural Record* had fewer average items in a room.

Figure 12

Stacked Bar of Mean Number of Items Categorized by Item Type and Listed by Month

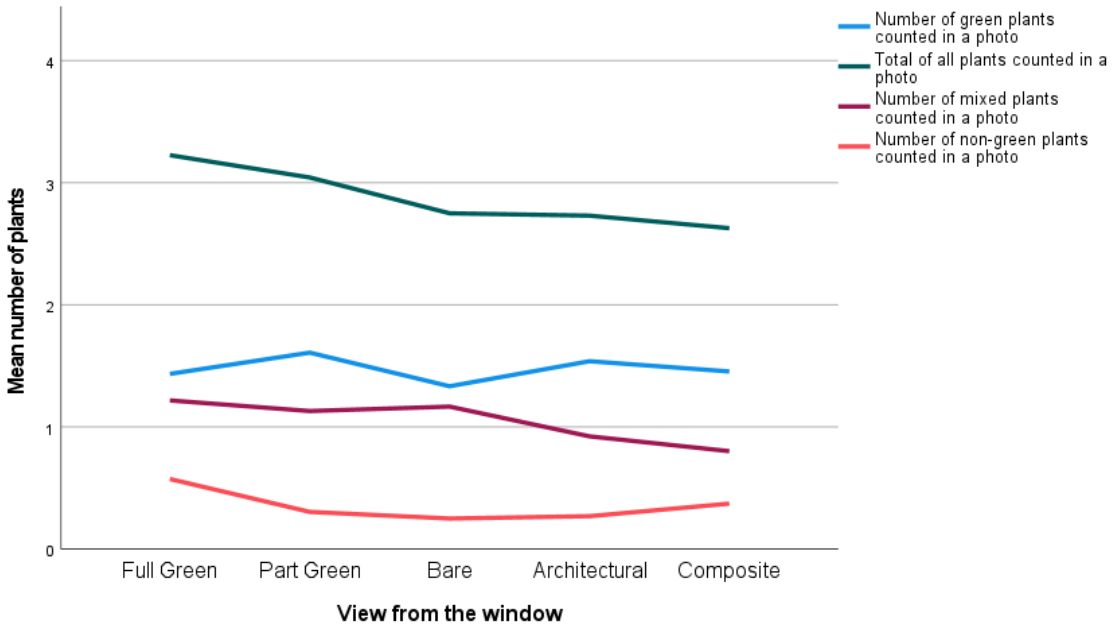


The line graphs in Figures 13 and 14 show the distribution of plants and analogues by type in relation to the view from the windows. These charts and the corresponding ANOVA compared the interior items with the window view. Figure 13 gives the breakdown of all plants by type of window view. The only plant type that represented a statistically significant relationship with the window variables was the non-green plant variable ($F = 2.466$, $df = 4$ and 292, $p = .045$). The highest mean of non-green plants was in the full green window category ($M = 0.59$, $SD = 0.826$) while the lowest was for bare windows ($M = 0.25$, $SD = 0.622$). This may show that people try to mimic the level of greenery viewable from the window of a given space. It may also indicate

that since a large percentage of window views were fully green, as indicated by Table 15, people might adjust plant types to add variety. The line graphs show a slight upward trend for total plants in the full green window category indicating that a somewhat higher number of plants are used when the view contains greenery as compared to the other views. These could suggest intention by the interior designer to compliment the view from the window, though more research would be needed to show statistical significance.

Figure 13

Mean Number of Plant Types in a Photo Listed by Window View

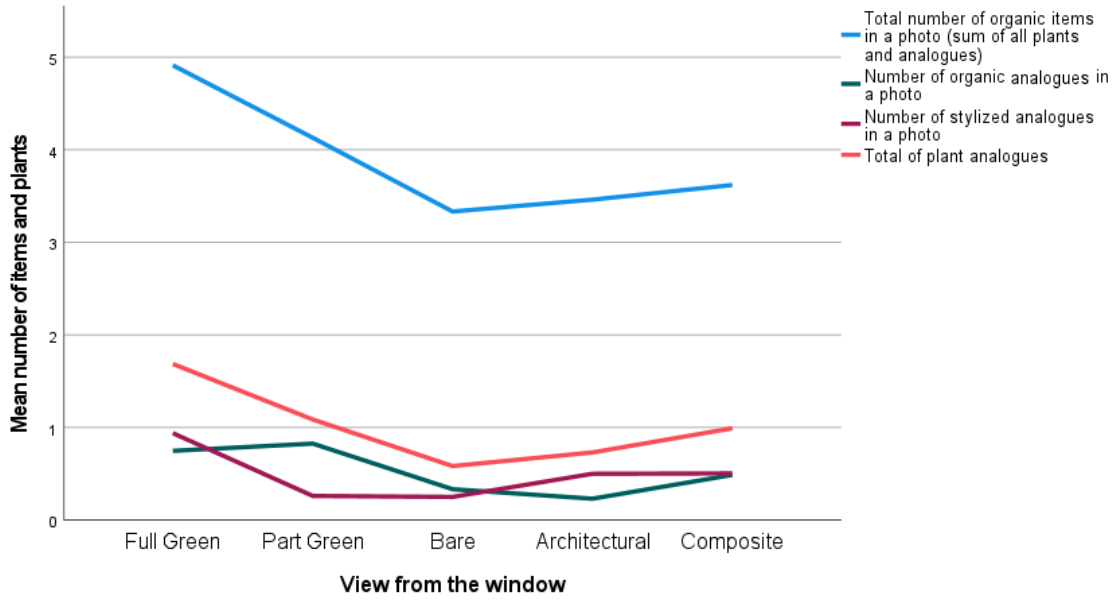


There is a significant relationship between the view from the window and the mean number of *all* items in the room, (F = 2.441, df = 4 and 292, p = .047). The highest individual mean for total items was in the full green category (M = 4.91, SD = 4.017) and

the lowest was for bare views (M = 3.33, SD = 3.393). Figure 14, like the previous chart, shows similarly directed trends among total items and organic analogues. It seems that as more greenery is viewable in a window, more plants are present. This could again corroborate the idea that designers may be trying to compliment the view of the window with more plants having lots of variety. It may also be an indicator that interior plant styling is restricted by the nature of the biome outside. It might be more difficult to host greenery in the home in a landscape where greenery is not as accessible, or during a time of year when plants are harder to grow.

Figure 14

Mean Number of Total Organic Items and Natural Analogues in a Photo Listed by Window View



Multivariate Models

As demonstrated at the beginning of this chapter in Table 5, there was no significant issue of multicollinearity among the social variables. None of the social factors presented strong relationships. The researcher created four multi-variate models for use in analysis.

Model 1 shows the three social variables regressed **on the total number of plants** in each room with an R-square of 17.4%. The model gives the Betas for the rate of hospitalization, violent crime, and poverty level. For hospitalization the relationship was strong and positive (Beta = 0.433, $p < 0.001$), meaning that generally when hospitalization is higher, the use of plants is higher. For violent crime (Beta = 0.158, $p = 0.003$), this number was weak and positive showing that violent crime and plant rates only slightly rise and fall together. The Betas for hospitalization and crime were both statistically significant. Model 1 supports the idea that the number of plants was positively correlated with hospitalization, but only showed weak connections for crime rate and poverty rate.

Model 1 Regression Equation

Total of all plants = -6.080 + 0.862 (Hospital Rate) + 0.003 (Crime Rate) – 0.019 (Poverty Rate)

Table 16

Model 1 – Social Variables on Total Plants Counted in a Photo

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-6.080	1.953		-3.113	.002
	Rate of hospitalization	.862	.106	.433	8.166	<.001
	Rate of violent crimes	.003	.001	.158	3.040	.003
	Rate of poverty	-.019	.107	-.010	-.180	.857

Model 2 shows the three social variables regressed on the **total number of plant analogues**. The R Square showed that this model explains only 1.4% of the variation in cases. The weakness of this model could stem from the way analogues are counted. Determining the analogues required more subjectivity than plants, and thus their number was harder to accurately represent. The order of magnitude for this model differed from the first with the largest standardized coefficients being crime (Beta = 0.117, p = 0.039). Crime was also the only variable in this model that maintained statistical significance out of the three. This could be indicative of the inherent relationship between health and naturally appearing items, demonstrating that when realistic plants are removed from consideration, the biophilic phenomenon is not nearly strong enough to be meaningful. Even so, the Beta for crime was quite small and the others are minuscule as well. This model cannot explain the effects of the social variables on plant analogues.

Model 2 Regression Equation

Total organic analogues = – .157 + 0.002 (Crime Rate) + 0.118 (Hospital Rate) – 0.045 (Poverty Rate)

Table 17

Model 2 – Social Variables on Total Organic Analogues

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.157	1.706		-.092	.927
	Rate of violent crimes	.002	.001	.117	2.067	.039
	Rate of hospitalization	.118	.092	.074	1.284	.200
	Rate of poverty	-.045	.094	-.028	-.478	.633

Model 3 shows the three social variables regressed on the **total number of items** in a photo (R^2 = 11.8%). Following a similar pattern to the plant-only variable, the strongest Beta in this model was the rate of hospitalization (Beta = 0.345, p < .001). The rate of crime (Beta = 0.176, p = .001) and poverty rate (Beta = -0.022, p = .686) both followed the order of the first model as well. There was a moderate, positive relationship for hospitalization and a weak, positive relationship for the rate of crime. Just like Model 1, hospitalization and crime were statistically significant while poverty was not. The addition of the analogues with plants seemed to reduce the significance and correlation of the results. This indicates that future studies in this area might benefit from a method that

considers the use of plants and analogues separately, or that the analogues must be measured in a different way than the means in this study.

Model 3 Regression Equation

Total items = – 6.236 + 0.980 (Hospital Rate) + 0.005 (Crime Rate) – 0.064 (Poverty Rate)

Table 18

Model 3 – Social Variables on Total Number of Items

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-6.236	2.884		-2.162	.031
	Rate of hospitalization	.980	.156	.345	6.288	<.001
	Rate of violent crimes	.005	.001	.176	3.281	.001
	Rate of poverty	-.064	.158	-.022	-.404	.686

Model 4 shows the three social variables regressed on **the total number of plants with large plants multiplied by two**. This model was the strongest of all multiple regression models in this study. The plant variable in Model 4 adjusted for the implication that large plants would provide more greenery and thus a stronger biophilic reaction than small plants. The R square for Model 4 indicated a strong relationship to the social variables accounting for about a fifth of the variation in cases (R^2 = 20.6%). Following Models 1 and 3, rate of hospitalization still had the largest standardized coefficient (Beta = 0.475, p < .001), followed once more by crime (Beta = 0.159, p =

.002) and poverty (Beta = 0.001, p = .984). The hospitalization rate presented a strong, positive relationship, crime was weak and positive, and poverty was weak and negative. The only variables of statistical significance were once again hospitalization and crime. This model showed slight increases in the R-square values and coefficients from Model 1 indicating that the decision to account for large plants as stronger imagery in the analysis was successful in showing better relationships between variables.

Model 4 Regression Equation

Total organic analogues = – 8.772 + 1.153 (Hospital Rate) + 0.004 (Crime Rate) + 0.003 (Poverty Rate)

Table 19

Model 4 – Social Variables on Total Plants with Large Plants Multiplied by Two

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-8.772	2.338		-3.751	<.001
	Rate of hospitalization	1.153	.126	.475	9.122	<.001
	Rate of violent crimes	.004	.001	.159	3.119	.002
	Rate of poverty	.003	.128	.001	.020	.984

a. Dependent Variable: Total number of plants with large plants multiplied by two

Windows and the Social Variables

Figures 15-17 show the relationship between social variables and the **view from the window**. Each graph represents the view from the window by type and ranked by what the social variable was during that year. Looking at these graphs, there was no significant intervariable change between each of the view types. The researcher added fit lines for each graph to show the average counts across views. In each graph, the line was nearly horizontal indicating little change between averages. There was a slight deviation for composite views in the line of the first graph representing window views by rate of violent crime. Violent crime presented the only statistically significant comparison of means within the window variables ($F = 2.761$, $df = 4$ and 289, $p = .028$). The other two graphs had no significance at the .05 level and contained no large variation in the fit lines. This might support the idea that violent crime has slight effects on the view from the windows. However, when considering the large rise and fall of the crime rate from Figure 6, it might be that the composite views are affected by other trends that happen to align with the rise and fall of the crime rates.

Figure 15

Scatterplot for Yearly Rate of Violent Crimes by Window View

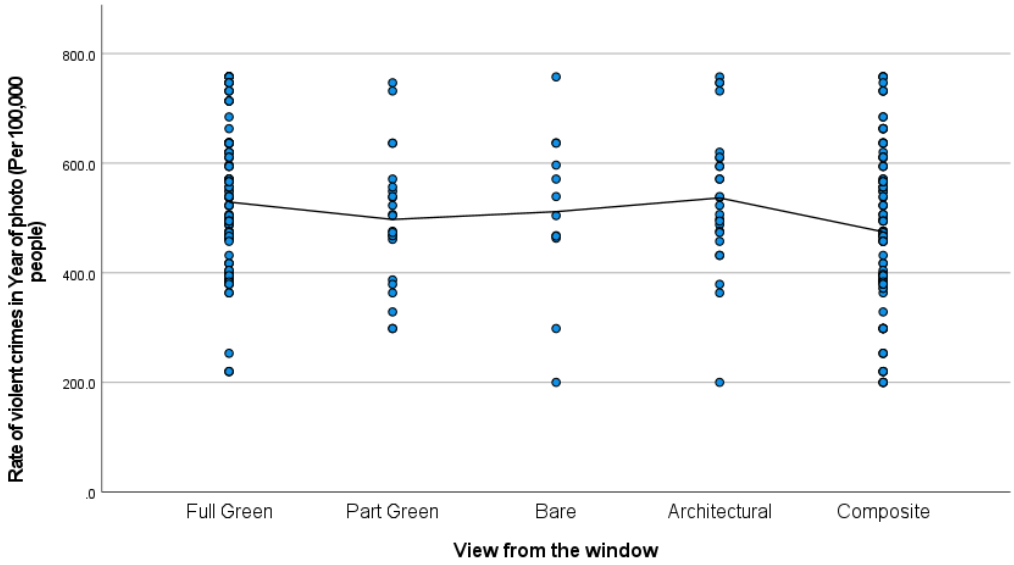


Figure 16

Scatterplot for Yearly Rate of Hospitalization by Window View

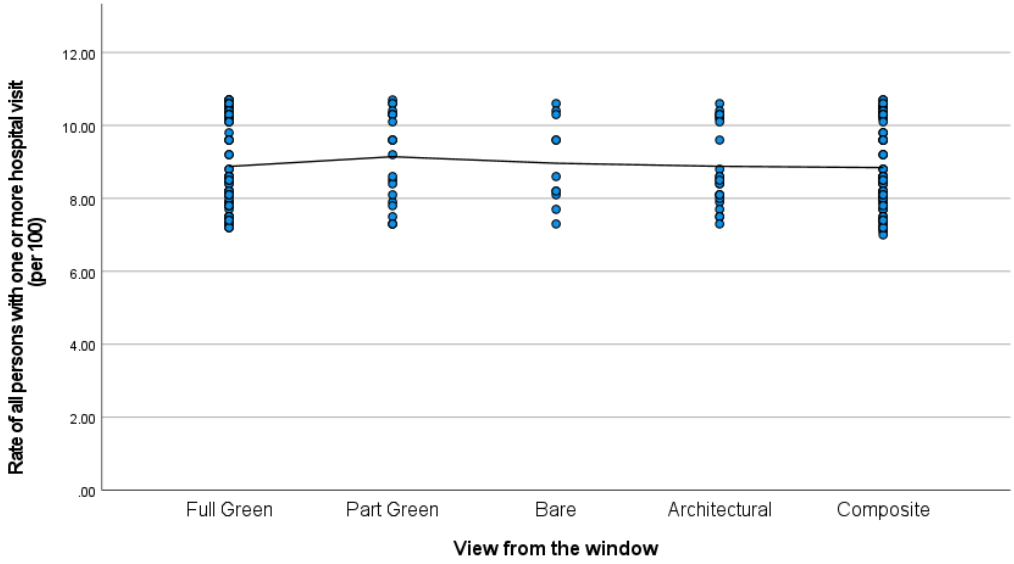
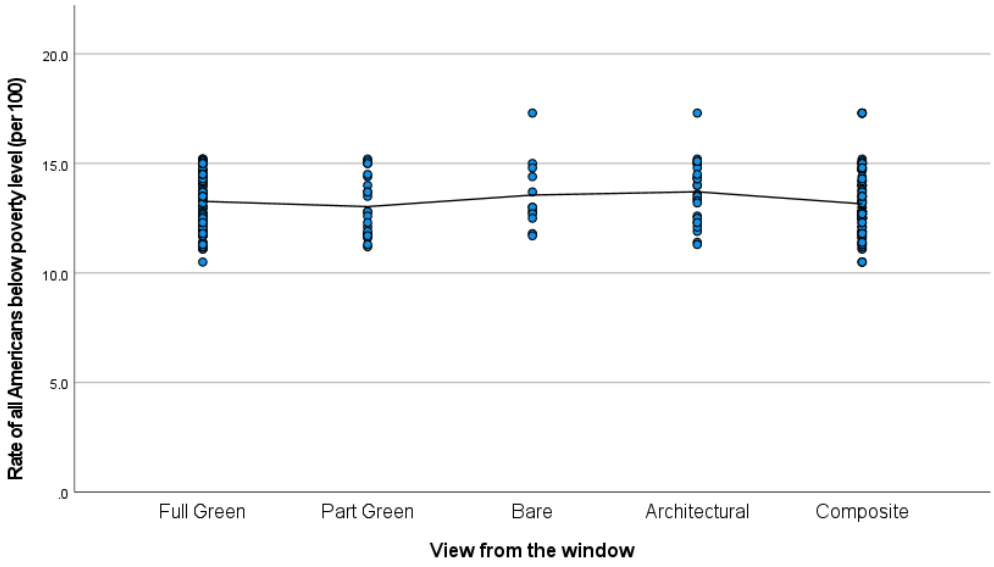


Figure 17

Scatterplot for Yearly Rate of Poverty by Window View



The four multivariate models show an overarching trend – while no model could accurately predict how many plants will be in a room, they did show consistently that when plants are an object of consideration, there was a moderate link to the rate of hospitalization in society. Additionally, when a model adjusted to account for plant size, this relationship was strong among other variables. This phenomenon has a direct tie-in to the literature discussions arguing for an inherent body/health link between humans and the natural realm. Whether a placebo effect, or a prescriptive health measure, this is for physicians and neuroscientists to decide, but the pattern remains: plants in the home are linked to societal health.

Chapter 5

Conclusions

This study brought together aspects of design from historical, cultural, and societal contexts to investigate how design changes over time. The focus of the study was the use of plants and plant analogues in interior spaces and how each relates to societal stress. The researcher collected data for hospitalization, crime, and poverty and analyzed photographs from historical design magazines to generate photo-ethnographic data. The study compared these two sets of data to examine how societal stress in America relates to plants in the home. This chapter addresses the research questions, discusses results, and proposes avenues for future study.

Research Findings

Research Question 1 - What kind of relationship, if any, exists between levels of stress in society and the use of plants in the home?

Model 1 showed that among the social variables, hospitalization rate and crime rate were the most important statistically. The results indicated a moderate positive relationship between hospitalization and the use of plants in the home ($r = .390$). This association was considered strong when adjusted for size ($r = .428$). As hospitalizations in a society increased so did the rates of plant use in depictions of the home. The hospital rate was the most effective variable in most of the multivariate models. These results

indicate how plants and health are connected. Higher rates of health-related stress are associated with higher numbers of plants in the home.

Research Question 2 - What kind of relationship, if any, exists between levels of stress in society and the use of plant-like objects in the home?

Model 2 seemed to indicate that the analogues are unrelated to the social variables. Significance values indicated there was no statistical significance ($p = .972$). This model should not be used to generate conclusions related to the use of items in a room. It is possible this stems from the difficult nature of establishing what counted as an analogue. The process of deciding what items were natural enough was far more subjective than determining what was or was not a plant. Further research would be required to analyze how plant-like imagery is related to social factors. A study focusing on a larger number of organic analogues in a wider range of contexts would be helpful in looking for such a relationship. These data do not support a relationship between social stress and plant analogues.

Research Question 3 - What kind of relationship, if any, exists between levels of stress in society and the types of views from windows?

Figures 15 through 17 show that for each window view type, the distribution of social variables remains largely the same. The only social variable that had a significant relationship with window view was crime ($p = .028$). However, Figure 15 did not show any large deviations between the mean crime rate according to window view. Overall, this indicates that the window view remains largely unaffected by the social occurrences

of the time. While the research method was effective in collecting and codifying data for the pictures, the statistics demonstrated that landscape views in magazines are generally unrelated to the societal issues for the people reading them. This kind of model as it relates to landscape might apply more effectively to created landscapes like those in paintings, media, or video games. The findings of this research suggest no statistically demonstrable relationship between societal stress and view from interior windows. The biophilic effect as described in the literature seems most associated with stress measures related to health and well-being and less to do with societal and financial concerns.

Supplemental Model Findings

In addition to the three research questions, two other regression models supplemented the research phase to try comparing the generated data in alternative ways. These included the summation variable that looked at all the plants and natural analogues added together and the large-plants-times-two variable to control for the size of plants in the study.

The summation variable is shown in Model 3 of the regression analysis. This model had similar patterns to Model 1, showing that the variable of greatest effect on the counts was hospitalization rate, followed by crime rate. The poverty variable returned in both of those models as not significant. The non-significance between poverty and the items may be because money is required to purchase items for the home and maintain plants. The overall results, however, were not as significant as the models that only considered plants, which indicates this modeling with these variables is most effective

when only considering the use of plants and excluding counts for plant-like items. This could support the idea that the organic analogues in this study were potentially misrepresented since organic structural elements were not included.

The final regression in Model 4 controlled for the size of plants in a room. During the coding process, the researcher included separate counts for large and small plants. Using size as a factor to adjust the variable, this model attempted to explain how the overall visual greenery in a room might affect results since a strict count alone would not be sensitive to size distinctions. The number of large plants was doubled and then added back into the count for analysis. Larger multiples of the large plant variable were tested, i.e., large plants times three or large plants times five, but significance did not change substantially as the multiple increased. Model 4 generated the strongest coefficient of determination in the study. This model accounted for 20.6% of the variation in cases. While not vastly different from the R-square of Model 1 (R^2 = 17.4%), the increase was still apparent and mirrored the increase in the Pearson's r between the unaltered plant variable and the plant variable that adjusts for size. The key takeaway from Model 4 is that *image perception* is an important component of this kind of study. It is essential to remember that the biophilic responses are largely based on visual appearance, not just the strict number of items or their physical material. Just as photos of lush greenery prompted better biophilic response than bare trees, a room of several large plants may prove more biophilic than a room with several small ones. Studies in the future need to control for this aspect as they examine other visually based phenomena in design.

Discussion

This venture began with the question "What will we create?" and from there included de Botton's central query regarding rationales for design styles: "Why do we change our minds about what we find beautiful?" From de Botton's lofty philosophical height a journey commenced through the field of art criticism to decide how such a question could be answered – certainly no easy task. De Botton played the card familiar to clever philosophers by proposing a simple question with multiple correct answers. Truthfully, his speculation can be concisely dealt with by an equally simple answer – people change ideals because they *feel like it.* Whether conscious of it or not, humans shape the world around them by pushing their internal world onto the external. Making personal judgements and acting on feelings are intrinsic aspects of the human condition. This study was able to shed some light on one of the motivating factors for design in the home: the relationship that people have to their own health.

While it is generally accepted that trends come and go, this study demonstrated how a trend can be charted, and showed the gentle waves of plants in and out of the home. This method could be used to plot other trends over time. The nature of measurement would have to change for things like materials and finishes. However, these could still be measured quantitatively as a percentage of visual space in the photographs. The increase in strength of relationships when accounting for plant size would support this idea. It seems that trying to account for the apparent visual amount of greenery can establish better relationships.

As with any study, certain methods here worked better than others. The implementation of the coding method produced statistically significant results and showed how trends in a subjective field could be tracked more objectively. An improvement to this method for future use would be to explicitly define a measure of *observability* to address objects that might fit countable criteria but are almost unseeable in photographs. This would be helpful in research that is based largely on visual perception, like art and design.

The researcher noted that this was a poor method to evaluate window views. While plants were easy to count and identify, views from the windows were often shrouded or blurry. Additionally, different magazine editors chose to focus on different portions of the room with some emphasizing windows and some not. *Architectural Record*, for example, showcased large windows with grand, unobstructed views of nature, whereas the other magazines, such as *House Beautiful*, often had the windows covered to emphasize elements of the room. Some rooms also utilized window coverings as décor, necessitating the window be closed and the view obstructed. More research is necessary to examine the psychological interaction with windows and window treatment. Beyond allowing occupants to control the prospect and refuge of space, window treatment can also showcase natural elements like in floral curtains or painted shades. This gives occupants an opportunity to control the amount and type of natural imagery that is showcased in the window elements of a room. It would be worth investigating this

aspect to see if this kind of control might affect people psychologically by creating peace or comfort, especially in environments of high use and stress like hospitals.

Future studies on the interaction between landscape and interiors should be aware of these challenges when choosing how to develop methods. One should take note that although the *Architectural Record* emphasized windows, Figure 11 shows that it averaged fewer plants per photograph than any other magazine – slightly less than two, compared to all other magazines averaging more than four per photo. This may be an indicator that where larger quantities of nature are available, there is less of a need to fill the space with potted plants. This may also be a result of the *Architectural Record* emphasizing architecture over decoration.

The use of multiple magazines was helpful for comparing multiple perspectives but also created problems when using the month variable. Without adjustment, the month attribute reflects more about the magazine that contributed the most photos to that month, as opposed to reflecting accurate data about the time of year. This could be alleviated by equalizing the number of magazine editions in months or performing investigation of a single magazine rather than many. Another solution to this problem is more data; a denser set of data points could shed more light on these trends and how they could be changing from season to season. The multiple magazines also created difficulties in sampling similar types of photographs. A relatively high rate of rejected magazines from *Architectural Record* showed the difficulty of using such a magazine for an analysis that specifically targets residential design. Although it required more analysis, the perception

of the researcher is that *Architectural Record* provides a unique perspective in the design field and would be worth including in a future study of similar nature.

Different sources of social data also created benefits and challenges for research. Collected data on stress showed that there were varied biophilic responses to the stress indicators. Most conclusions from this study point to significant connections between plants and health data. This tracks well with contemporary research on plants and their psychological benefits. The other social data revealed patterns of interest and point to future areas of potential research for environmental psychologists. The relationship between plants and poverty presented as statistically significant, but much weaker than the health connection. In each multivariate model, poverty was the weakest and least significant variable. This could indicate an issue with using poverty in this area of study. Although poverty is a clear cause of stress in the literature, the topic of examination here is how to relieve stress, not stress itself. Because plants and interior items cost money to purchase and the magazines also have a cost to access, it is unlikely that this data would be directly relevant to the impoverished. When household budgetary restraints are considered, this makes sense. If stress is being caused by high levels of poverty, the solution will not likely include spending more money.

These are key points for highlighting ethical considerations for how this data can be used. Improper reading of this document might encourage people to address their distress with a new plant. While it remains clear that unwell people have something to gain from natural exposure, this project should not be used to argue that plants are the

panacea to poor health. Instead, these results support careful consideration of nature's role in the home, and encourage ways to integrate natural components, when cost effective, that work alongside other wellness practices. This study shows that social factors are related to the way that people express themselves in space and media.

Finally, when comparing the three social variables, crime rates often returned as the least significant and weakest relationships. The one area where it was more significant was in comparison with the different types of window views. The crime significance here may indicate a relationship between society and what it chooses to showcase in media. While hospitalization and poverty are largely personal factors, violent crime was more related to the perception of how people see the whole of society. This is supported by the literature discussion and indicated in the data by the higher crime rate measured by 100,000 as opposed to 100 for the other variables. The connection could show that photos with certain window views have more to do with the message the magazine wants to portray, rather than how the owner choses to style their home. More directed research on landscape preference in homes would be required to investigate the phenomenon.

Application

This research approach was able to map the use of plants in residential spaces as their numbers rise and fall year to year. This has implications for the way people think about changing styles. For years, trending styles have presented a mysterious guessing game, prized by those tastemakers in charge of shaping the great worlds of fashion and

design. This study showed that interior design features can be quantified. Future studies might use the same techniques to explore patterns, texture, or even the prevalence of certain colors. With enough data, it is possible to build models that approach highly predictive aspects. Research has already been conducted using digital file compression techniques to analyze photographs for biophilic design concepts like *fascination* (Berto et al., 2015). These kinds of studies demonstrate precedence for models enhanced with computer learning to process large amounts of data very quickly and reliably in a way that a single human researcher cannot.

Without further research, this study cannot verify causality between rates of hospitalization and plants, but it does show a clear link between a design element in the home and social factor in society at large. This phenomenon is observed anecdotally in personal experiences with societal customs. For example, hospital gift shops are full of flowers. When someone is sick what better way to cheer them up than with a card and bouquet? Anniversaries, birthdays, sick days, funerals – in all these times where people wish to encourage positive emotion there is a vase of roses promising to do just that. Other studies could examine these phenomena at the personal level to see if similar plant/health trends appear. Further research in this area should also consider lag effects when making use of this data to look for causality. Because the societal factors involving the psychology of a nation are so broad, it makes sense that their greater effects within the culture could show up months or even years after an initial stimulus rather than immediately. This study compared the data with its immediate temporal counterpart.

Researchers looking for a causal effect should make use of data sliding techniques to compare how the use of plants might change related to prior phenomena, e.g., stress data from three months before, six months, one year, etc.

By advocating for this kind of work and deciding how to apply these findings in evidence-based design strategies, the design field can be rendered more effective at promoting health and well-being for users in a variety of contexts. By discovering what it means to design well, designers can build a more effective and ideal version of the world for the people of today, at least until people change their minds again about what they find beautiful.

Conclusions and Recommendations for Future Research

The results in this study answer many of the researcher's original research questions. Results support the following conclusions:

1. There is a moderate, positive relationship between number of plants and the rate of hospitalizations over time from 1965 to 2020.
2. When adjusted for size, the relationship between number plants and hospitalizations can be defined as strong and positive.
3. There is a weak, negative relationship between the number of plants and the rate of poverty over time from 1965 to 2020.

Conclusions not supported by the data are as follows:

1. The results cannot support any relationship between social factors and plant analogues.

2. There is no clear relationship between social factors and the view from an interior window.

Recommendations for further research include:

1. Replicate the study using the same instrument with different historical design artifacts to increase validity and reliability.
2. Adjust the month variable to contain equal proportions of each magazine to generate conclusion about seasonals trends.
3. Use pattern and texture in a photograph by measuring the overall percentage of visual space occupied by certain natural items.
4. Use number and size of windows to create approximations for how much exterior imagery is viewable from a room.
5. Create new variables to measure design finishes like material, pattern, texture, and color.
6. Refine variables that evaluate natural analogues to include architectural elements and exterior construction.
7. Reapply this model in the context of exterior architecture.
8. Employ computer learning to evaluate photographs based on visual complexity rather than a researcher-based approach.
9. Evaluate created landscapes like those in art, media, and virtual reality using this model.

10. Investigate how much natural material is necessary to promote specific health outcomes.
11. Develop alternative methods of evaluating population health and/or stress for use in refined studies.
12. Direct study towards interaction effects to see if plant use could boost other wellness measures like psychological intervention and medication.

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Appendix A

Item Evaluation Rubric

Number of Plants in the photo:

Total number of Plants in photo

# of GREEN* (a complete or near completely green foliage plant, some minute coloring may be present)

# of MIXED (a plant that is a near 50/50 mixture of green and non-green plant components, would include a flower arrangement of foliage and color flowers)

# of NON-GREEN (a completely or near completely color arrangement or non-green organic plant, includes cut flowers and bare stem arrangements)

*as best as possible, black and white photos will be determined by leaf and flower patterning, leaves will be considered green and flower will be non-green

# of GROUPED plants (plants arranged together in the room)

# of GROUPS (number of arrangement groups in the room, excludes single plants)

# of UNGROUPED plants (single pot arrangements of plants)

# of LARGE plants (plants that are visually approx. 5 feet or larger or that take up a visual breadth of approx 3 feet, including large palms, ficuses etc.)

# of SMALL plants (includes plants and flower arrangements smaller than 5 visual feet of height and 3 visual feet of breadth

Number of plant analogues: (note this does NOT include organic patterning related to animal forms) each item to be counted as one regardless of sharing patterns e.g. multiple pillows of the same pattern would each count individually, does NOT include structural components of the room like wall paneling, papering or molding)

TOTAL number of analogues

# of ORGANIC	(item closely resembling a real plant, i.e. photograph or natural patterning using plant motifs)
# of INORGANIC	(item inspired by or related plants but containing versions or colors of the shapes unlikely to be found in real nature e.g. highly symmetrical or simplified versions of the plant)

Window views:

Type of windows

STANDARD only	(windows at the standard level of the room, would correspond to a maximum approximate height of a standard door 6'8", would still include transom windows attached to a level door or window)
CLERESTORY only	(windows above the level of the room, would correspond to an approximate height above a standard door 6'8", does NOT include transom windows; does include skylights and floor to ceiling windows)
BOTH	(includes both types of windows)

Window Treatments

Treatment YES	(any type of treatment over or around windows – curtains, drapes, blinds, that could functionally change the window view; does NOT denote structural components like stiles or lites)
Treatment NO	(no treatment of the window is present)

Type of view:*

FULL GREEN	(natural view is fully green, does not consider sky views)
PART GREEN	(a view with partial elements of green but still all natural)
BARE	(non-green view of nature with no architecture i.e. snow, ocean etc.)
ARCHITECTURAL	(a completely architectural view, no natural element)
COMPOSITE	(combination of natural and architectural features, includes architectural features of the house that exist as a large portion of the view)
MISSING**	(view is obscure, unavailable, or can't be undoubtedly determined by the coder)

*To the best of ability black and white photos were coded based on the presence of items in the window view

**Does not include photos where only a portion of windows are unviewable, if at least one view is present in the photo that view was be recorded for coding purposes

Time of day

Day / Night	(time of day in the photo, most easily identified by the level of light from windows

Each photo is also tagged (by name) with the

YEAR	(year of publication)
MAGAZINE	(magazine of photo origin)
EDITION	(monthly edition of the magazine)

Each photo is noted with the applicable page number where it was found in the magazine.

Appendix B

Supplemental Tables and Figures

Figure B1

Count of Editions by Month, Architectural Digest

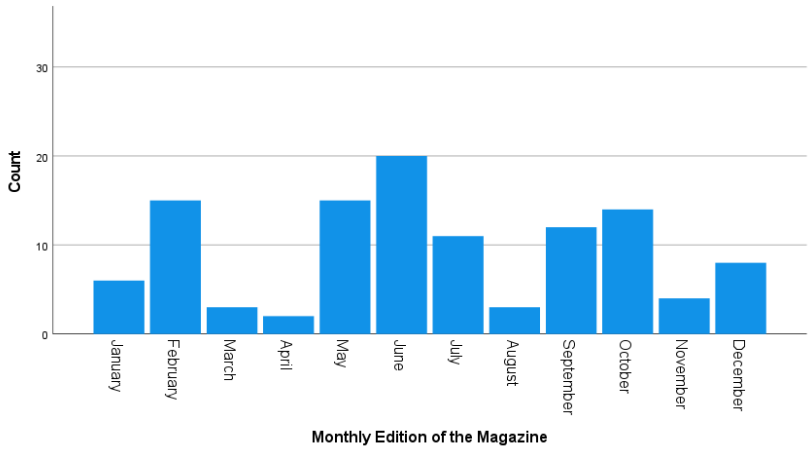


Figure B2

Count of Editions by Month, Architectural Record

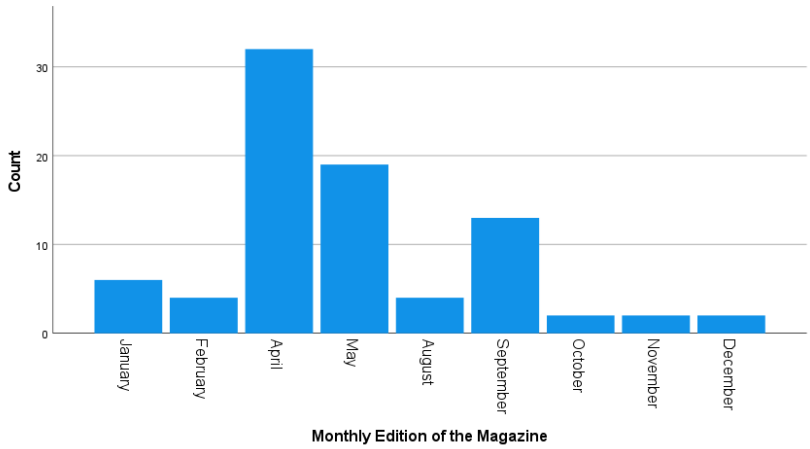


Figure B3

Count of Editions by Month, Better Homes and Gardens

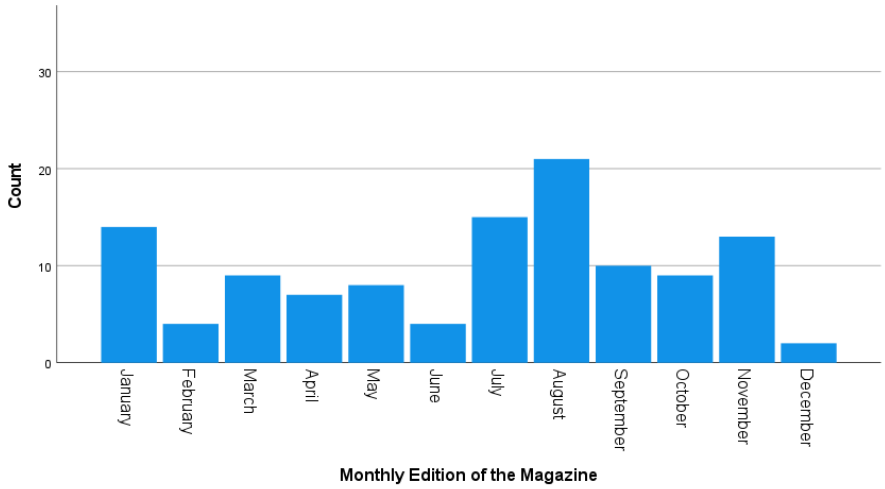


Figure B4

Count of Editions by Month, House Beautiful

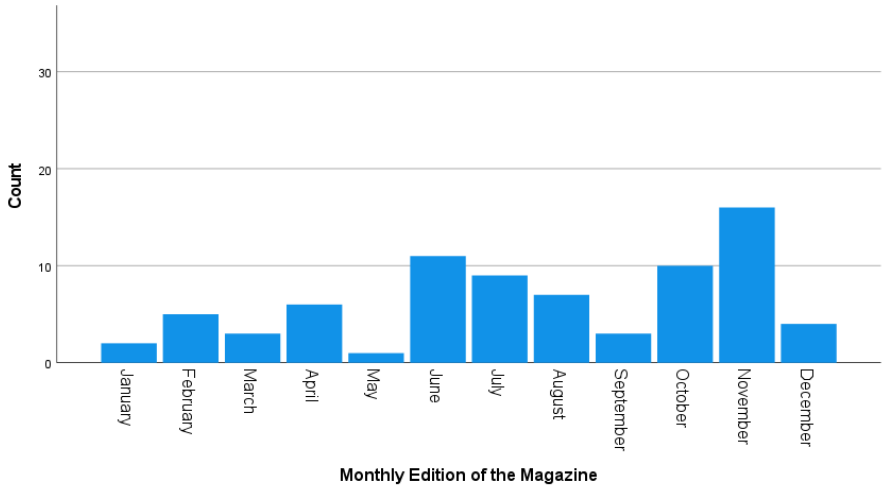


Figure B5

Percentage of Photos by Number of all Plants Counted in a Photo

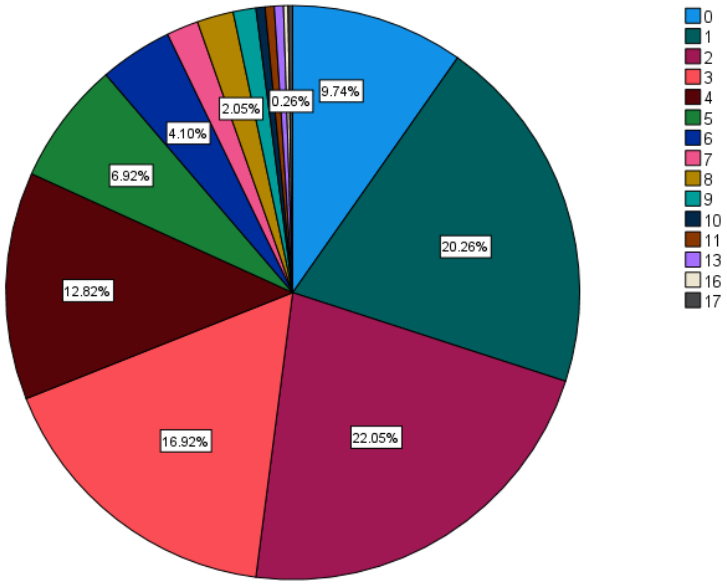


Figure B6

Percentage of Photos by Number of all Green Plants Counted in a Photo

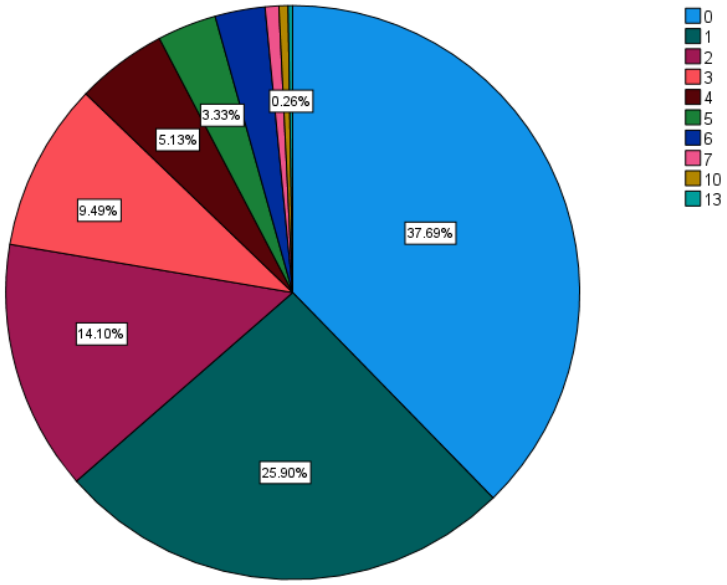


Figure B7

Percentage of Photos by Number of Mixed Plants Counted in a Photo

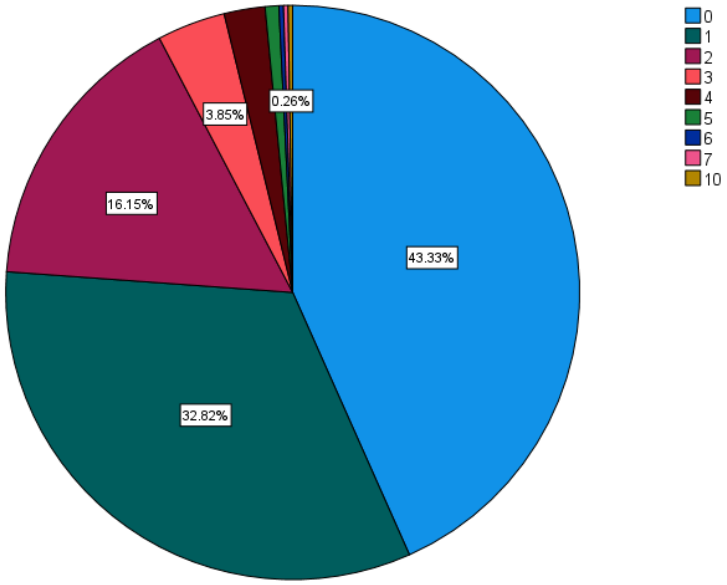


Figure B8

Percentage of Photos by Number of Non-Green Plants Counted in a Photo

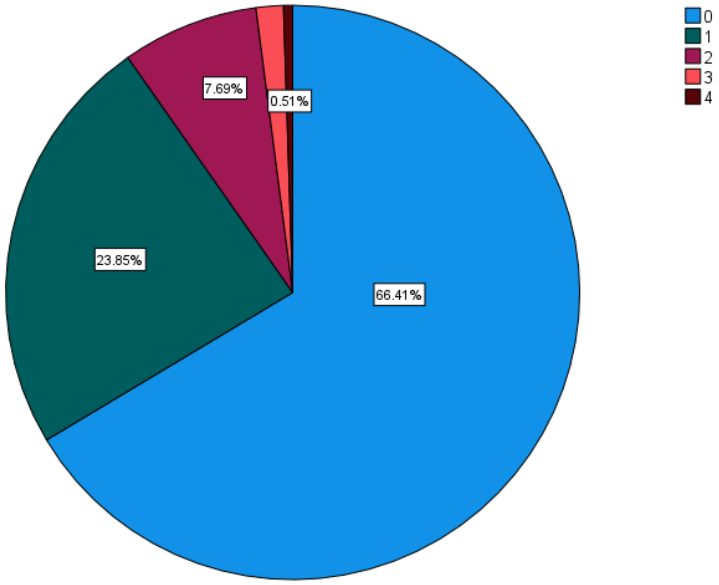


Figure B9

Percentage of Photos by Total Number of Organic Items in a Photo

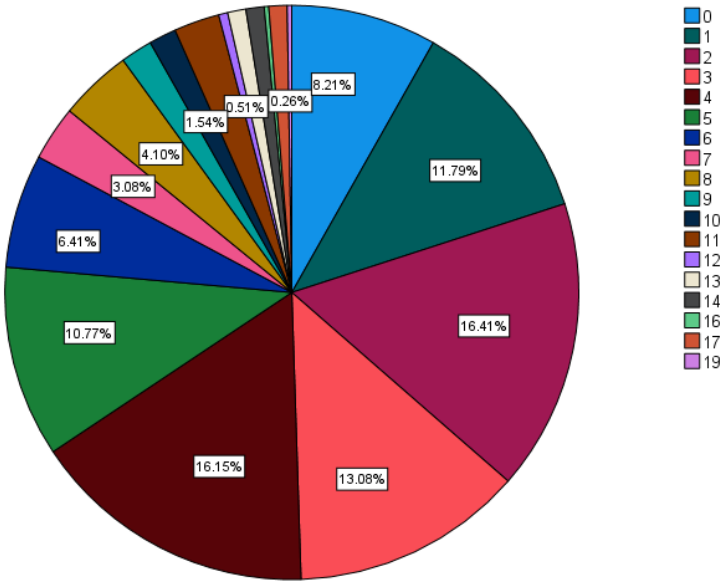


Figure B10

Percentage of Photos by Total Number of Plant Analogues

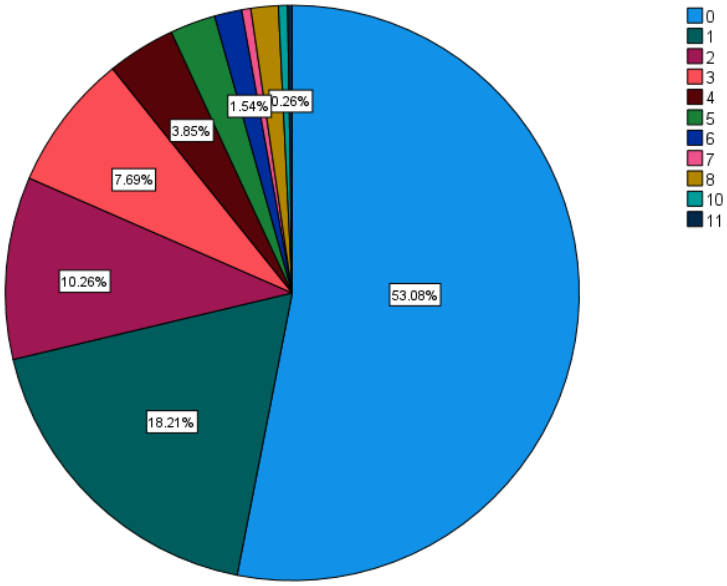


Figure B11

Percentage of Photos by Number of Organic Analogues in a Photo

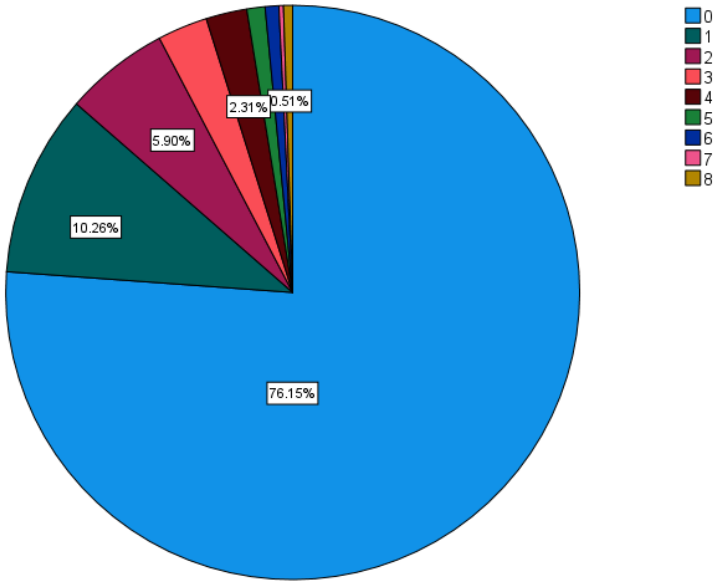


Figure B12

Percentage of Photos by Number of Stylized Analogues in a Photo

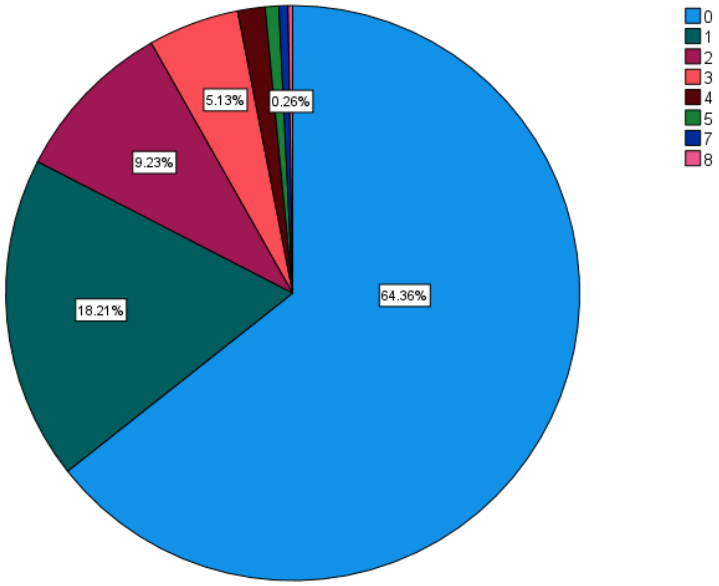


Figure B13

Types of Windows in the Photos

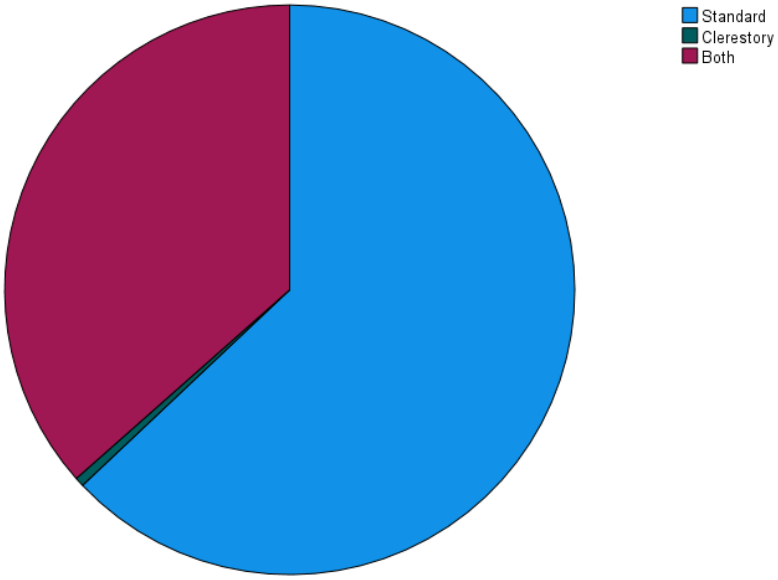


Figure B14

Whether or not the Window has a Treatment Applied to it

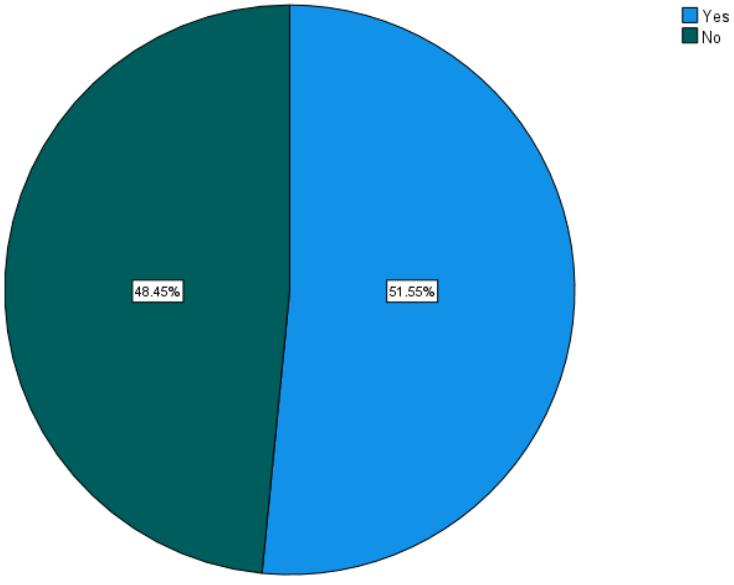
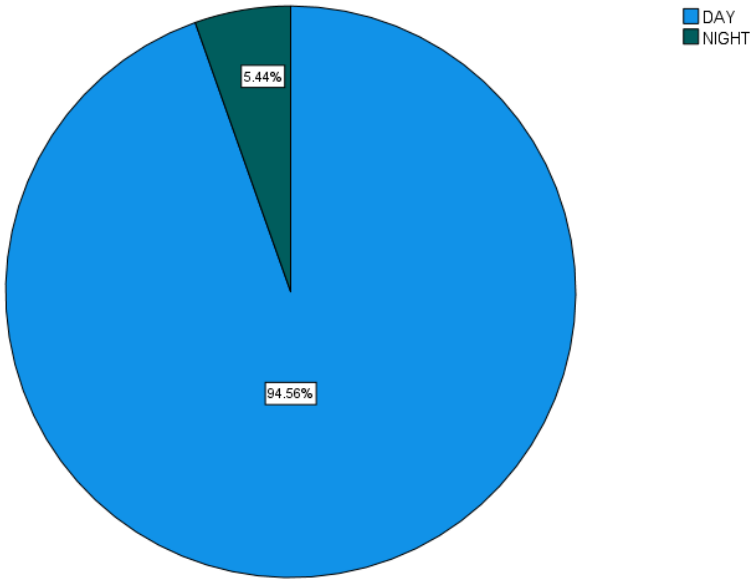


Figure B15

Time of Day when the Photo was Taken



Appendix C

Example Photographs

Figure C1

HB-1966-07-p79

Figure C2

AD-1970-06-p74

Figure C3

AR-1970-08-p95

Figure C4

BHG-1985-07-p33

Figure C5

HB-1986-06-p54

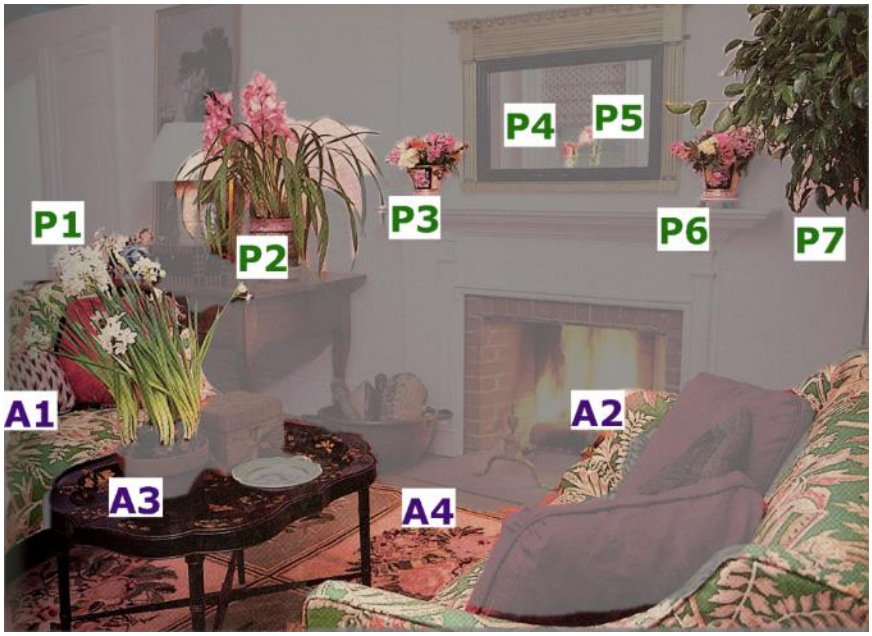


Figure C6

HB-1986-06-p54 (2)

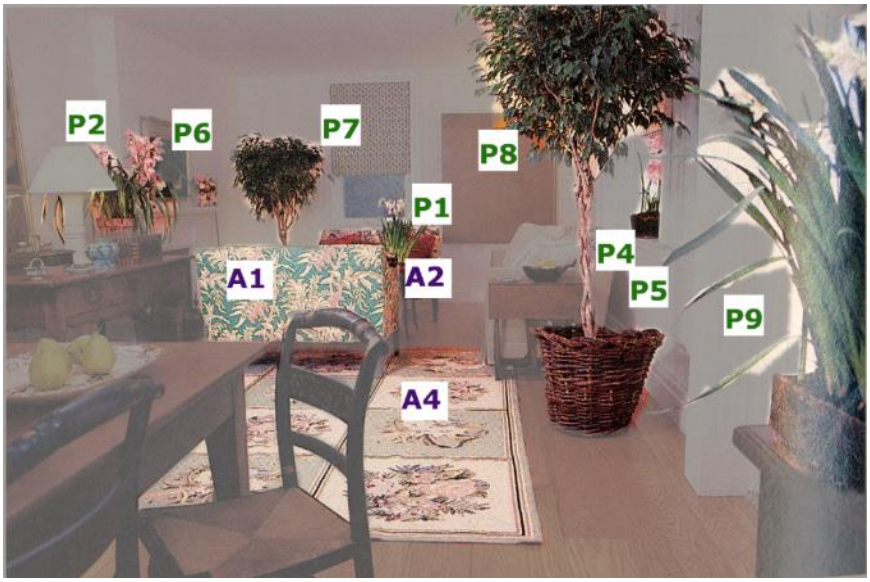


Figure C7

BHG-1992-08-p67

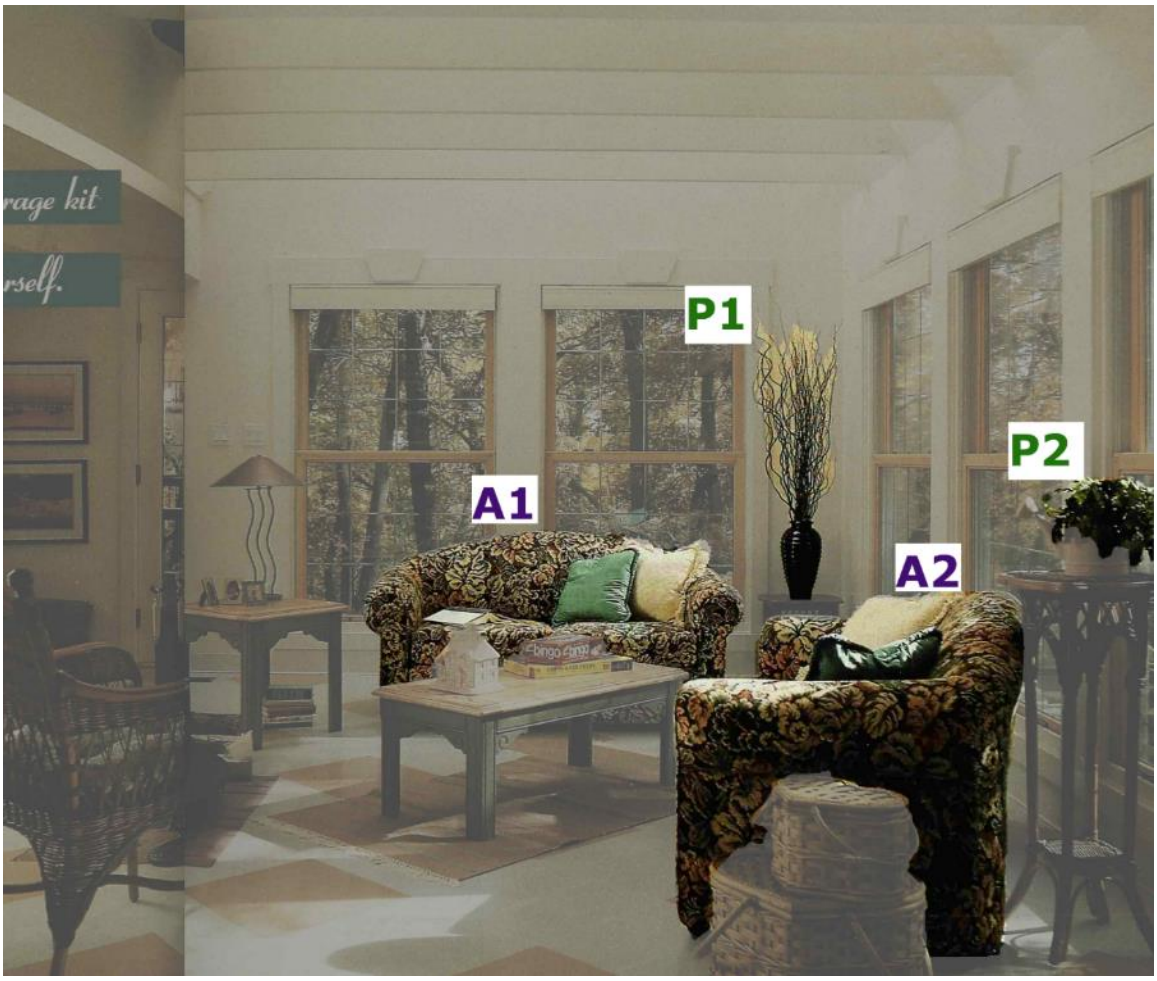


Figure C8

HB-2000-08-p101

Figure C9

AD-2001-07-p108

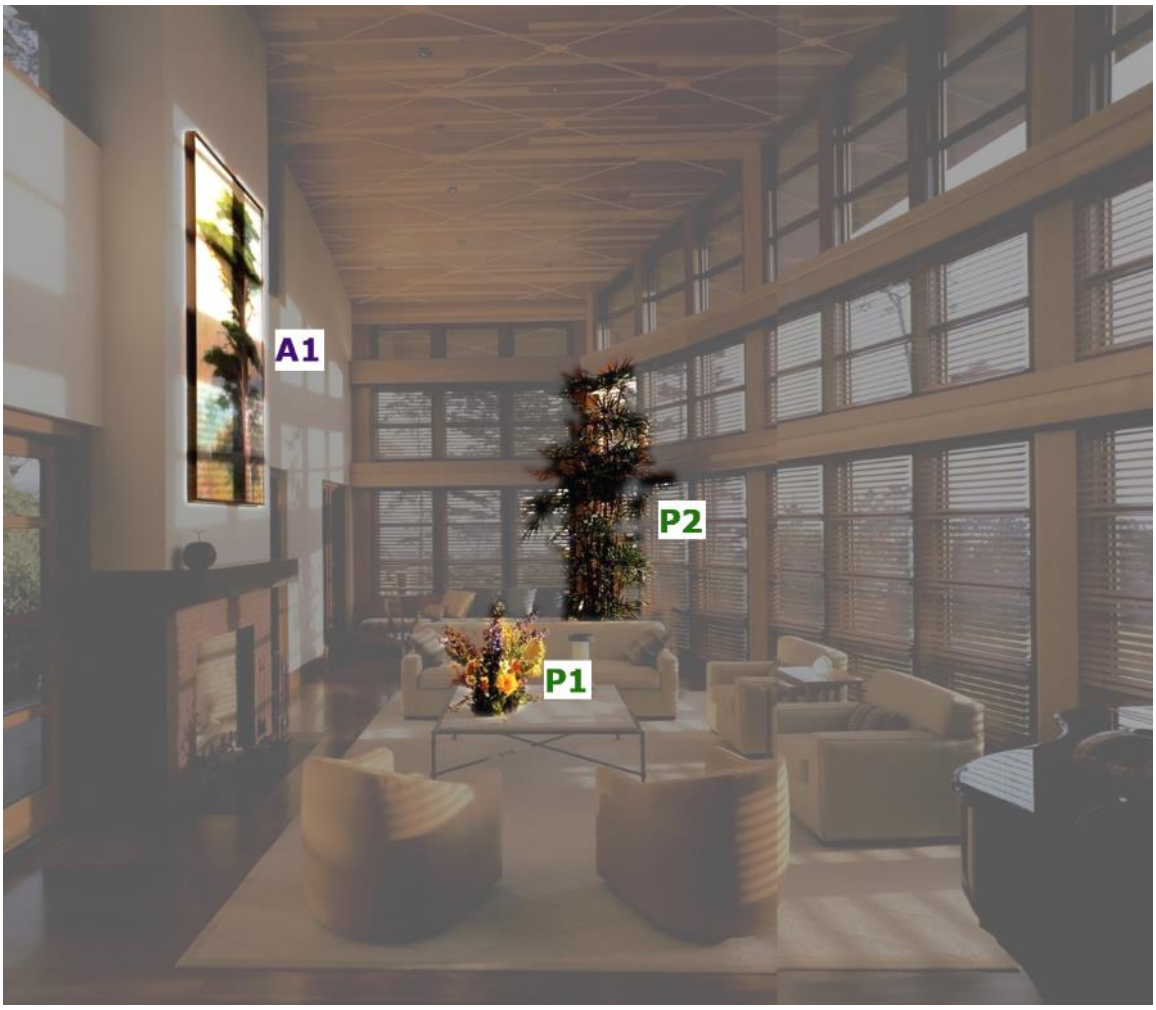


Figure C10

AR-2012-04-RH-p61

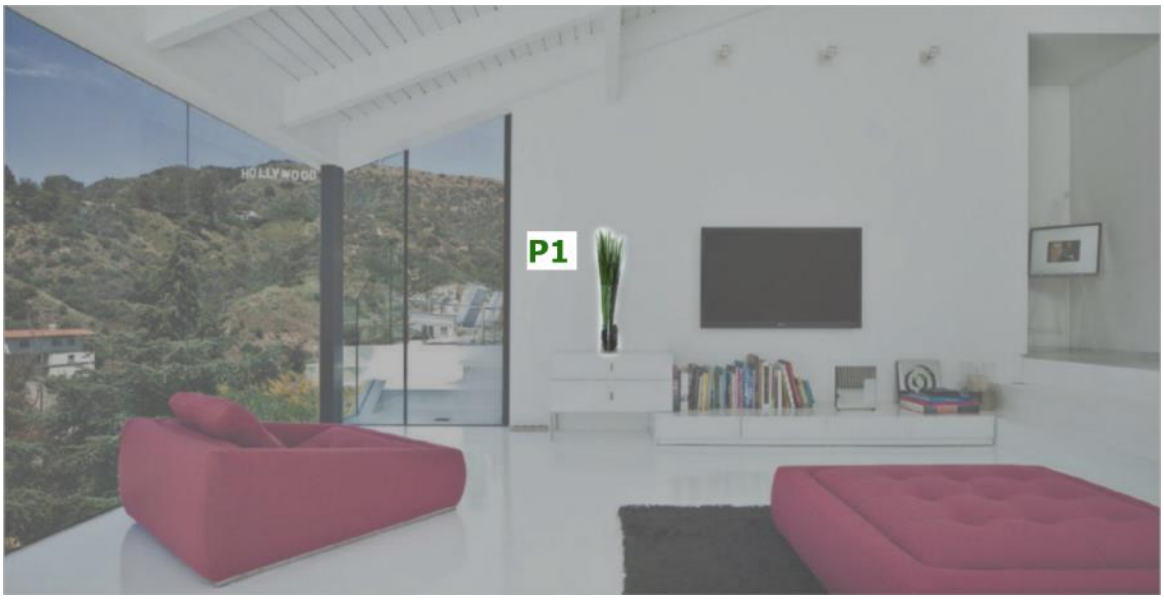


Figure C11

BHG-2018-08-pZ3

VITA

After earning a degree from Nacogdoches High School in 2013, Trenton Birdwell attended Stephen. F Austin State University in Nacogdoches, Texas. In December of 2016, he received the degree of Bachelor of Arts in English. He currently works full time as an academic advisor in the SFASU College of Science and Mathematics. He also works part time completing floor plans and elevation drawings for various interior design firms in Houston, Texas. In 2018, he entered graduate school at Stephen F. Austin State University, and in August 2022 he received the degree Master of Science in Human Sciences with an emphasis in Interior Design.

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