LOOKING GOOD, FEELING BETTER, DOING GREAT: POST-OCCUPANCY EVALUATION REPORT ON HEALTH CARE PROFESSIONALS WORKPLACE SATISFACTION

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Suchiu Autumn Lin

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Abimbola O. Asojo
Advisor

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Abstract

Work-related stress among health care professionals has resulted in high turnover rates, which in turn leads to serious problems in the health care industry. Previous studies have shown that visual design elements can affect or even mitigate health care professionals' perceived stress and therefore influence their workplace satisfaction. The purpose of this exploratory study was to examine the effects of visual design elements such as window view, color, and artwork as potential factors contributing to health care professionals' workplace satisfaction. Considering how learned knowledge (e.g., cognitive expectations) might influence individuals' perception of their workplace environment, this study tested for differences in workplace satisfaction between individuals who were informed about the positive effects of the design elements and those who were not. An observational cross-sectional, Internet-based survey instrument was used to collect data from a representative convenience sample of 224 health care professionals practicing in a Medical Office Building in the Northwest region of the United States.

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CHAPTER ONE: INTRODUCTION

Background

A study conducted by Ulrich in 1984 to examine correlations between the physical environment and patients' health outcomes was groundbreaking. In the study, Ulrich compared patients' recovery conditions following cholecystectomy surgery. He divided patients into two groups, one that stayed in rooms with tree-view windows and one that stayed in rooms with brick-view windows. Having controlled for factors such as age, gender, weight, year of surgery, and floor level, he then compared these two patient groups in terms of several different variables. He concluded that access to natural views had a positive therapeutic influence on patients' well-being – patients whose rooms had tree views had shorter postoperative hospital stays, had fewer negative evaluative comments from nurses, took fewer moderate and strong analgesic doses, and had slightly lower scores for minor postsurgical complications (Ulrich, 1984).

Ulrich's study established a new field of health care design research, one that has subsequently produced a large corpus of studies linking patients' health outcomes to the designed environment (Codinhoto, Tzortzopoulos, Kagioglou, Aouad, & Cooper, 2009; Devlin & Arneill, 2003; Dijkstra, Pieterse, & Pruyn, 2006; Huisman, Morales, van Hoof, & Kort, 2012; Schweitzer, Gilpin, & Frampton, 2004). It was also one of the earliest studies incorporating experimental study design, namely, intentionally assigning a treatment (room with a tree-view window or room with a brick-view window) to observe

outcomes (patient's recovery). In this latter sense, it was a precursor for the development of evidence-based design methodology that has since become widespread in the health care design field (Stichler, 2011; Zimring *et al.,* 2008).

Most of the earlier studies seeking to improve patient outcome through design have centered primarily on patients. In recent years however, researchers have also begun to broaden their perspective and consider ways in which environments might be designed to help health care providers deliver better care to their patients (Eisenberg, Bowman, & Foster, 2001). Eisenberg *et al.* argued, "a healthier workplace in the health care industry would result in healthier patients – that is, healthy and happy workers provide higher-quality care" (p. 444). Studies by DeVoe, Fryer, Hargraves, Phillips, and Green (2002) also demonstrated a relatively strong linkage between health care professionals' workplace satisfaction and the patient's health outcomes. These studies focused in particular on attempting to understand how the designed environment can influence the psychological and physiological health of those who work within health care environments (DeVoe *et al*., 2002; Eisenberg *et al*., 2001; Huisman *et al.,* 2012).

One factor lending urgency to the focus on creating healthier environments for health care professionals in the design field is the high levels of stress currently suffered by health care professionals (Linzer *et al*., 2009). Work related stress among health care professionals has resulted in high turnover costs (Applebaum, Fowler, Fiedler, Osinubi, & Robson, 2010). According to Linzer *et al*. (2009), almost half of the physicians they surveyed in their study reported their jobs were moderately or highly stressful, more than

a quarter of them reported feeling burned out, and close to one third of those surveyed intended to leave their workplaces within two years. This greater turnover rate because of stress in turn leads to increased costs for the health care industry. In a survey conducted by Buchbinder, Wilson, Melick, and Powe (2001) for example, more than half of 507 physicians studied (55%, 279 physicians) ended up leaving that practice, resulting in over $69 million in turnover costs. The 2014 National Health Care and RN Retention Report (na, n.d.) reported that the national average total turnover rate for registered nurses (RN) is 14.2%, and the average cost of turnover of a bedside RN ranges from $44,380 to $63,400. This results in the average hospital losing between $4.21 million and $6.02 million annually because of turnover costs. High levels of stress have also been identified as a reason that potential future health care professionals have been hesitant or reluctant about entering the health care field (Beecroft, Dorey, & Wenten, 2008).

Few studies have attempted to find explanations or suggest solutions to reduce the workplace-related stress experienced by health care professionals. Some argued the potential psychological impact of the designed environment could be used in mitigating negative emotional states such as stress. As stated by Zimring *et al*. (2008) in a literature review of evidence-based health care design, "well-designed physical settings play an important role in making hospitals less risky and stressful, promoting more healing for patients, and providing better places for staff to work" (p. 4). Some claimed that incorporating certain design elements could help create a healing environment. As noted in a literature review by Dijkstra *et al.* (2006), factors such as sunlight, window views,

and pleasing olfactory stimuli were found to be related to workplace satisfaction. Minor changes such as rearranging seating in order to encourage communication and eye contact was found to positively improve participants' emotional states. It is important to note that most of the studies outcomes were based on participants' subjective feedback. Use of a representative study sample and valid instrument thus became critical components in these types of studies.

Problem Statement

Brill, Margulis, and Konar (1984) argued that although it is not easy to attribute users' behavior to specific aspects of the designed environment, environmental design research has established "causal relationships between the design of places and the behavior of individuals and groups" (p. 14). In their book, *Using Office Design to Increase Productivity*, Brill *et al*. claimed that their study was the first to systematically measure the influence of various aspects of the office's physical environment on "job performance, job satisfaction, satisfaction with work environment and ease of communication" (p. 9). The authors stated that by consciously manipulating "building elements in a purposive manner," one could shape and/or support the users' behavior and activities (p. 17). Among the 18 factors they examined, they found most influenced individuals' workplace satisfaction (i.e., environmental satisfaction), including furniture, noise, lighting, display, appearance, windows, etc. (Brill, *et al.,* 1984). This is a classic study that was the foundation for many subsequent studies.

Studies since have focused on the effects of specific visual design elements in the workplace environment and their impact on workers' sense of well-being and/or workplace satisfaction. Elements studied have included, among others, daylight and window views (Alimoglu & Donmez, 2005; Kaplan, 1993; Largo-Wight, Chen, Dodd, & Weiler, 2011; Leather, Pyrgas, Beale, & Lawrence, 1998; Manning, 1970); artwork (Marcus & Barnes, 1999; Rollins, 2010; Sadatsafavi, Walewski, & Shepley, 2013); and color (Clarke & Costall, 2007; Elliot, Maier, Moller, Friedman, & Meinhardt, 2007; Evans, 2003; Holtzschue, 2011; Kwallek, Soon, Woodson, & Alexander, 2005; Tofle, Schwarz, Yoon, Max-Royale, Des, & Thanks, 2003). When viewed collectively, however, the findings of these different studies are often ambiguous, inconsistent, or, in some cases, contradictory. Evans (2003) for example concluded that there was "no clear evidence" that color affected mood, emotions, or psychological well-being in "any systematic manner" (p. 541). By contrast, in a later study conducted by Clarke and Costall (2007), the authors found that color could in fact affect individuals' emotions in a multi-faceted way, especially in relation to individuals' cultural backgrounds and prior experiences. These contradictions and ambiguities in findings are especially problematic in studies seeking to examine correlations between visual design elements and occupants' well-being.

One possible explanation for these contradictory findings, as suggested by Clarke and Costall's study, is that these studies often failed to account sufficiently for the degree to which individuals' responses might be influenced by pre-existing expectations or

assumptions based on their demographic backgrounds. A study by Heerwagen and Zagreus (2005) similarly concluded that individuals' expectations or assumptions could impact their resultant experiences of a specific environment. In their study of the first Platinum-LEED building in the United States, the researchers found that overall satisfaction with the building was higher than individual satisfaction with any individual component. For example, despite almost 40% of the people being unhappy with the acoustics, overall satisfaction nonetheless was still near 90%. The authors concluded that the occupants in general expressed high levels of overall satisfaction in part because of "the values conveyed by the building, [and] the sense of pride that occupants experience…" (p. 24).

Studies like these highlight the need for researchers to formulate a more robust methodological approach for health care design studies, one that allows for more nuanced interpretation of subjective responses by subjects and clearer definition of the relationship between design elements and desired outcomes. The subject of the study, the effects of visual design elements in the workplace environment on health care professionals' psychological states, was chosen because responses in this area are typically highly subjective and therefore serve as an excellent subject with which to develop this methodological approach.

Research Purpose and Research Questions

The study by Heerwagen and Zagreus (2005) discussed above suggested that

subjects' positive views regarding sustainable buildings could influence their overall experience of their environment. A study conducted by Langer (2009) in 1981 offered more concrete evidence for the impact the environment could have on occupants, affecting them not only psychologically but also physiologically. Langer brought eight men in their 70s and 80s to a monastery in Peterborough, New Hampshire for five days. The interior of the monastery had been redecorated to create an environment that simulated the year 1959 in every possible way, down to the programs broadcast on the TV or shows and music heard on the radio. Participants were asked to live as though it were twenty years earlier, when they were in their 40s and 50s. Participants in the treatment group were moreover encouraged to "act" as if it were decades ago, and to discuss historical events as if they were current. Langer measured participants' physical conditions before and after the five-day retreat. She found noticeable improvement in physical health in not only the treatment group but the control group as well. Participants experienced improvements in height, weight, and posture. To her surprise, they also experienced improvements in their hearing, eyesight, appearance, memory, and cognitive ability (p. 10-11). Although not without its shortcomings, e.g., the small sample size, for example, or the short period of time over which the study was conducted, Langer's results highlight the degree to which a particular environment might produce physiological and/or psychological effects on people experiencing it.

Building on these existing studies, this thesis explores psychological consequences of design decisions made regarding visual design elements within a health

care environment on health care professionals. In other words, it explores how "what one sees" (e.g., the designed environment) influences "how one feels" (e.g., stress reduction) and, by extension, "how one acts" (e.g., workplace satisfaction). Acknowledging that individuals emotional states are often influenced by learned knowledge (cognitive expectations) (Heerwagen & Zagreus, 2005), this thesis also explores to what degree the effect, or lack of effect, of visual design elements on psychological states is shaped by individuals' conscious or subconscious expectations or assumptions of what that effect should be.

This study aims to investigate: 1) the influence of visual design elements on individuals' workplace satisfaction, and 2) how learned knowledge (cognitive expectations) affect individuals' overall workplace satisfaction. The research questions for the present study include:

1) What relationships exist between the presence (or absence) of visual design elements (e.g., exterior window views, artwork, and accent color) and health care professionals' workplace satisfaction?
2) Does workplace satisfaction differ between health care professionals who are informed prior to the survey that certain visual design elements have health benefits and those who are not so informed?

Two online, self-administrated questionnaires were developed and distributed to health care professionals who work in a health care facility to gather relevant data to answer these research questions.

Significance of the Study

This study examines subjective assessments of health care professionals' workplace satisfaction using an observational cross-sectional study design. It makes a unique contribution to existing methodological approaches because it incorporates an experimental design component into a POE survey; in other words, it randomly divides subjects into two groups to examine the outcomes (workplace satisfaction) based on the treatment (informed facts). In so doing, this study demonstrates how this approach might be used as a methodological tool for predicting the effect of design factors in a health care environment.

This study hopes to contribute to the growing body of research demonstrating the tangible effects of the specific visual design elements on healthcare professionals' sense of well-being and workplace satisfaction. Design professionals can use the POE instrument to identify factors that affect health care professionals' workplace satisfaction. If the study proves to be successful, that is, if it demonstrates that workplace satisfaction can be improved and sustained through use of informed facts (e.g., learned knowledge), further studies to measure the quantifiable outcomes based on the implementation of the treatment may also be applicable.

Definition of Terms

Double-blind: treatment assignment is concealed from participants and investigators in an experimental study design. It also known to be that the researchers do not know who the subjects are and vis-à-vis. (Motulsky, 2013)

Evidence-based design (EBD): the process of basing design decisions about the built environment on credible research to achieve the best possible outcomes (The Center for Health Design, n.d.).

Hawthorne effect: first described by Elton Mayo during studies of worker productivity at the General Electric Hawthorne Works near Chicago between 1927 and 1932. It refers to the tendency of subjects who know they are being observed to temporarily change their behavior. Later it evolves to describe the degree to which workers attempt to provide the answers they believe are sought by their superiors.

Novelty effect: while people often notice design elements at first, they overlook them after a period of time because the changes are no longer new.

Workplace: any physical place where a worker or self-employed person is engaged in an occupation (Occupational Health and Safety Act, n.d.).

CHAPTER TWO: LITERATURE REVIEW

This chapter reviews literature studying three visual design elements – exterior window views and natural light, artwork, and accent colors on wall surfaces – within the health care workplace environment. It includes the relevant findings from studies exploring the influence of visual design elements in the workplace on individuals' stress levels, and how these visual design elements influence workplace satisfaction. This chapter also discusses the theoretical framework, i.e., therapeutic environment theory from the field of environmental psychology, which was used to elucidate relationships between the designed environment and individuals' workplace satisfaction. Finally, the hypotheses of this study, along with the proposed research model, are also identified based on the literature review.

Visual Design Elements and Health Care Workplace Satisfaction

The literature review is divided into three parts: work-related stress in the workplace environment; visual design elements in relation to health care workplace satisfaction; and cognitive perspective in relation to health care workplace satisfaction.

Work-Related Stress in the Health Care Workplace Environment

A study conducted by Kaplan, Talbot, and Kaplan (1988) surveyed 168 subjects divided into three different categories of employees to investigate the connection between work-related stress and workers' well-being. The authors found that subjects suffered a

considerable degree of work-related stress, and that this stress affected their physical health and general well-being. Stress at the workplace, as defined by Lazarus and Folkman (1984), is a "particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being" (p. 19). Work-related stress in a nursing population, for example, has been linked to burnout (e.g., emotional exhaustion, depersonalization, and lack of personal accomplishment) and general health (McGrath, Reid, & Boore, 2003), or low job satisfaction and an increase in actual or intended turnover among employees (Applebaum *et al*., 2010). In examinations of physicians populations, work-related stress was found to be associated with low job satisfaction and increased intent to leave practice (Linzer *et al*., 2000), or with higher malpractice risk (Jones, Barge, Steffy, Fay, Kunz, & Wuebker, 1988; Mahmood, Chaudhury, & Valente, 2011).

To date, many studies have attempted to identify factors that might contribute to health care professionals' work-related stress or affect how much and to what degree that stress is experienced. Existing studies have for example examined environment factors (e.g., noise) (Applebaum *et al*., 2010; Mahmood *et al*., 2011); organizational factors (e.g., supervisor support, autonomy, and work load) (Gholamzadeh, Sharif, & Rad, 2011; Tsai & Liu, 2012); and individual demographic variables (e.g., age and years of work experience) (Holtzschue, 2011; Sadatsafavi *et al*., 2013). The study conducted by Harris, McBride, Ross, and Curtis (2002) highlighted several kinds of sources of stress in a health care environment, including interior design (e.g., equipment, furniture, finishes,

color, layout), architectural design (e.g., window view), social factors (e.g., privacy), ambient environment (e.g., lighting, noise, temperature), and maintenance/housekeeping. Although the study mainly focused on the environmental satisfaction of patients, these factors nonetheless could similarly affect the workplace satisfaction of health care professionals as well (Sadatsafavi & Walewski, 2013).

The health care professional workplace is a complex environment; work-related stress can thus occur on many levels. In a study conducted by Djukic, Kovner, Budin, and Norman (2010), the authors noted that nurses in their study sample perceived their physical workplace environment negatively and as a result, the physical workplace environment could be a source of stress. Kaplan and Kaplan (1989) therefore proposed creating an overall supportive environment, i.e., a restorative environment, to help individuals coping with stress. The authors examined qualities that characterize such an environment, e.g., nature, and concluded that an environment designed to be restorative could yield psychological benefits.

Visual Design Elements in Relation to Health Care Workplace Satisfaction

One element in the restorative environment was natural views, which were characterized by their capacity to assist recovery from mental fatigue and their minimal cognitive effect (i.e., lack of complexity) (Kaplan, 1995; Kaplan & Kaplan, 1989; Leather *et al.*, 1998). A number of studies suggested that other elements of the designed environment—such as artwork and color—might have a restorative capability similar to

natural views (Clarke & Costall, 2007; Nanda, Eisen, Zadeh, & Owen, 2011; Rollins, 2010).

In examining the relationship between natural views and work-related stress, Kaplan and Kaplan (1989) concluded that "[a]ccess to nature at the workplace is, in fact, related to lowered levels of perceived job stress and higher levels of job satisfaction" (p. 162). The authors found that most of the workplace restorative benefits involved some kind of outdoor activities, e.g., being outdoors and/or being able to see outside. The authors also claimed that workers who had nature views (e.g., trees/bushes, grass, flowers) and worked outdoors had lower levels of job stress than those who had either no outdoor views or views of built elements (e.g., street, parking lot, other buildings). Similar findings were also reported in some of the later studies; for example, the studies conducted by Kaplan (1993) and Largo-Wight *et al.* (2011). Both studies surveyed large samples (i.e., 615 and 1,622 office workers) to increase the generalizability and validity of their research.

Leather *et al*. (1998) studied the relationship between sunlight penetration, nature views, and job satisfaction among 100 employees who worked in a wine-producing organization. After controlling for the variables of gender, adaptation, and occupational status, the authors found that the better the window views in the workplace, the more positive the responses received from subjects' self-surveys regarding job satisfaction, intention to quit, and general well-being. The authors found that sunlight penetration was also related to general well-being and job satisfaction. Alimoglu and Donmez (2005)

surveyed 141 nurses who worked in Akdeniz University Hospital in Antalya, Turkey, and found that nurses who where exposed to more than three hours of daylight in a work shift reported lower work-related stress than those exposed to less daylight. In an earlier study using both interview and two distinct post-occupancy evaluation surveys, Manning (1970) also found that study subjects were overwhelmingly positive about being able to see out of an office and having daylight in their workspace. Manning however found that the content of the view made no statistically significant difference in the results; what mattered was having the outside view. Manning also found the regardless of age, gender, or other demographic factors, color scheme generated the most discussion and disagreement.

In contrast to studies of window views and natural light, there have been relatively few studies investigating artwork and color in relation to health care professionals' stress conditions in the health care workspace environment. This is likely due to the difficulty in conducting such studies given the highly subjective nature of artwork and color interpretation, as well as the difficulty in obtaining concrete tangible evidence for the effects of these visual elements (Sadatsafavi & Walewski, 2013). A few studies have attempted to draw parallels between the effects of visual access to nature views and artwork, claiming that certain kinds of artwork could produce restorative effects analogous to that of nature views. Rollins (2010) for example stated "nature art will best promote restoration across diverse groups of people" and therefore can mitigate the stress of the environment (p. 73). An earlier study identified a correlation between

different types of artwork and workers' psychological states, noting that the "more stressed people feel, the more they yearn for simple, familiar images and forms; and the more they will be distressed by negative or ambiguous images" (Marcus & Barnes, 1999, p. 225). It is important to note however that there seemed to be little tangible evidence supporting the conclusions of either study.

In a large, multi-facilities survey study that examined 27 different architectural and physical features in patient areas, workspaces, and staff areas, Sadatsafavi *et al.* (2013) found visual elements such as window views and artwork had relatively little effect on workplace satisfaction when compared with finishing materials, indoor air quality, and furniture design. They did, however, observe a positive correlation between these visual elements and employees' well-being in non-clinical staff areas. Sadatsafavi and Walewski (2013) explained that difficulties in drawing concrete conclusions from measurements of self-reported perception of the quality of workplace was likely due at least in part to sampling variables (i.e., the subjects in different studies are different) and time (i.e., the responses received may be different over time).

Additional evidence for the positive influence of artwork on health care professionals responses to the workplace environment comes from a small body of research on their emotional reactions to different art program, e.g., the Circle of Care Retreat (Medland, Howard-Ruben, & Whitaker, 2004) and Arts-in-Medicine (Repar & Patton, 2007). However, while these two studies did integrate artwork in their programs, they heavily emphasized hands-on art experiences rather than visual stimuli. A study

conducted by Fazlić and Mustajbegović (2010) is one of few that focused on visual artwork in the health care workspace environment. Their findings demonstrated that health care staff's motivation and loyalty increased after their workspace had been decorated with artwork.

Studies attempting to explore associations between color and mood have often produced ambiguous and/or inconsistent results. Correlations between particular colors and individuals' emotional responses or behavior across different studies have been more consistent with only certain colors: the color red (and/or sometimes orange), for example, was perceived to be more arousing, stimulating, and exciting (Mahnke, 1996; Beach, Wise, & Wise, 1988); blue (and/or sometimes green) was perceived to be more secure, calming, and soothing (Mahnke, 1996). Inconsistencies across studies are in part due to the fact that "color is sensed by the eye, but perception of color takes place in the mind, and not necessarily at a conscious level" (Holtzschue, 2011, p. 4). Responses are to some degree socially conditioned. Elliot, *et al*. (2007) for example have argued that the effects of color are mostly based on learned meaning. Their study suggests that color associations and color impacts are context and culture specific, often occurring without individuals' conscious awareness. The authors illustrate their point by noting that interpretations of the color red can be influenced by associations of the color with certain contexts, i.e., associated with psychological danger of failure and/or mistakes due to our educational system because red pens have traditionally been used by teachers when

grading papers and exams, or because of certain cultural associations, i.e., associated with love and romance because of red roses symbolizing romantic love.

Studies of correlations between color and mood within the workplace environment, while acknowledging that color did indeed affect the "experience and performance of people in particular environments" (Tofle *et al.,* 2003, p. 4), results have also often been similarly ambiguous or inconsistent. In one of the few investigations that studied color in relation to workplace environments, Kwallek *et al*. (2005) examined the impact of different colored offices, i.e., white, predominantly bright red, and predominantly light blue-green, on workers' perceived performance and job satisfaction. The authors surveyed 90 randomly sampled subjects after a 4-day experiment and found subjects working in the red office reported the color to be more distracting than subjects working in the monochromatic white and blue-green offices. In this study, the color red was perceived as a stressor; it negatively affected workers' psychological well-being. However, as pointed out by Mahnke (1996), the actual experience of colors in the workplace environment may be less dramatic than these associated effects because although any strong color can cause a noticeable initial reaction in individuals who experience it, the effect may not last long. Individuals simply get used to the color if exposed to it for an extended period (Rashid & Zimring, 2008).

Existing Experience in Relation to Health Care Workplace Satisfaction

Several studies have argued that individuals' subjective responses to their environment are greatly influenced by existing learned knowledge (cognitive

expectations). Proshansky and Murphy (1970) for example have argued that since "we *learn to perceive* in much the same way that we *learn to act*" (p. 120), held opinions and biases about what we perceive strongly influence how we then experience. Holtzschue (2011) has similarly emphasized the importance of existing experiences on how perception is interpreted, arguing that "everything seen is understood because its identity has been learned and the experience of it held in memory" (p. 50). Holtzschue claims that all new sensations can be associated with stored information, and that the familiarity of existing responses would then be diffused to any new perception.

Factors influencing the interpretation and response to what is perceived can include cultural background, demographic characteristics, and/or previous work experiences. Studies of one visual design element – color – for example have shown that color recognition and association often results from learned information based on social and cultural traditions (Clarke & Costall, 2007; Fitch & Bobenhausen, 1999; Holtzschue, 2011; Tofle *et al*., 2003). They have demonstrated that "cultural standards modify perception and perceptual input [which], in turn, modifies our aesthetic response" (Fitch, 1988, p. 5). In other words, color may not necessarily carry any inherent emotional meaning but "changing moods and emotions caused by our own physiological and psychological makeup at the moment interact with color to create preference and associations that we then link to the color-emotion response itself" (Fehrman & Fehrman, 2004, p. 108).

Age and years of work experience also appear to play important roles in how

individuals respond to the designed environment. In the study conducted by Sadatsafavi *et al.* (2013) for example, authors surveyed a total of 496 health care professionals from eight acute-care hospitals about their workplace environment. They concluded that younger employees and those who were newer to the facility tended to appreciate the architectural and physical features more than older employees. In a study drawing responses from 2,500 clerical workers comparing individual differences in the workplace environment, Wells (1970) found that previous workspaces appeared to have "a considerable influence in shaping attitudes" to how these workers felt about their new workspaces (p. 488).

Other factors influencing responses to the workplace environment include awareness of the expert opinion of professionals (e.g., architects and interior designers) about the workplace as well as the prestige of the workplace's organization (e.g., brand-name companies). Preiser and Nasar (2008) stated that architectural appearance is often treated as visual art, and it "transforms the architect and juror into a kind of priest, who delivers cultural knowledge to the uneducated masses. The intimidated public often goes along, lacking confidence in their 'aesthetic' judgment and feeling uneasy challenging the expert" (p. 88). The expert's judgment therefore could be viewed as "a form of power," often carrying more weight than the opinions of the general public (Gesler, Bell, Curtis, Hubbard, & Francis, 2004, p. 120).

A similar positive correlation between individuals' satisfaction and prestige of the hospital or organizational brand can was identified as well in Kim, Kim, Kim, Kim, &

Kang (2008). Kim *et al*. argued that the interaction between the occupants and the building name (i.e., organizational brand name) appeared to merge as a two-way process that connected the perception of the brand and the self, i.e., the stronger hospital/organizational name resulted in more satisfied customers (Kim *et al*., 2008). In addition to brand, Gesler *et al*. (2004) suggested that even using key phrases such as "patient-centered care" and "therapeutic environments" could improve psychological expectations about the hospital services for both patients and staff and, by extension, improve how the health care environment was experienced.

Theoretical Framework

This study is guided by therapeutic environment theory, a theory developed in the field of environmental psychology that focuses on the exploration of interrelationships between human behaviors and their surrounding environment. It also adapts Kanizsa's Triangle to highlight the uncertain nature of the perceived benefits of visual design elements.

Therapeutic Environment Theory

Environmental psychology is the study of the relationship between human behavior and the physical environment (Bell & Sundstrom, 1997; Cassidy, 1997). In the case of the designed environment, it theorizes that this interrelationship is dynamic and interactive, rather than simply linear and causal (Proshansky, Ittelson, & Rivlin, 1970). Environmental psychology is guided by the principle that if human reactions to their

immediate environment can be identified and understood, it may be possible to generate some communal criteria for planning environments that support occupants' well-being and activities rather than forcing people to be "satisficed," i.e., accept available options as satisfactory, with adverse environmental conditions (Stokols, 1987, p. 30).

Because research in environmental psychology focuses on the "cyclical, feedback model of human cognition and behavior, and pertains broadly to human transactions with the sociophysical environment" (Stokols, 1987, p. 30), studies need to be conducted within the "existing, built environment, and natural settings" (Bell & Sundstrom, 1997, p. 375), i.e., in real-life settings with real life actors. The research method developed more than two decades ago within this field for assessing the effects of design interventions in relation to occupants' satisfaction and for testing hypotheses scientifically is the post-occupancy evaluation (POE) (Preiser, Rabinowitz, & White, 1988). POE is defined as the "process of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time" and is an effective way to evaluate person-environment transactions (Preiser, 2001, p. 9).

Developing an appropriate external validity instrument (i.e., POE questionnaire) is essential to the effectiveness of a study. Several web-based POEs that have been rigorously tested and refined are available to the public. The Buildings, Benchmarks, and Beyond-Minnesota Sustainable Post-Occupancy Evaluation Survey (B3-SPOES) for example, developed by the Center for Sustainable Building Research (CSBR) at the University of Minnesota, is used to reflect sustainable building design criteria and is

designed to be compatible with national guidelines (Choi, 2011). The POE most widely used by researchers is that developed by the Center for the Built Environment (CBE) at the University of California, Berkeley. It has already been used in studies of more than 70 buildings (Zagreus, Huizenga, & Arens, 2004). The POEs from these and other sites were a rich resource heavily utilized in developing the POE questionnaire for this study.

One important set of factors that can influence how results of the instrument should be interpreted is the demographic characteristics of participants, in particular age and years of work experience. As shown by the three studies included in Yadav's (1987) edited volume *Perceptual and Cognitive Image of the City*, the way in which people are aware of and think about the built environment often reflects prior knowledge and earlier experience. Kaplan and Kaplan (1989) make similar claims as well. They argue that individuals' functioning within an environment depends on information, and that much of the information essential to individuals' functioning within an environment has already been accumulated from previous experience. Differences in demographic factors such as age and work experience can also explain inconsistencies in responses from workers to the same built environment: their perceptions and expectations of their current workplace environment differ because of dissimilar amounts and kinds of experience accumulated from previous employment (Lee, 2006). For this reason, the POE questionnaire designed for this study includes questions about these and other demographic characteristics of the participants.

Environmental psychology studies typically rely entirely on observation and self-report surveys. Given the subjectivity of the responses these studies typically receive, it is challenging to generalize their results as applicable beyond the population they surveyed. One way in which the subjectivity of responses might be improved is by introducing an experimental component to the surveys. Several studies have demonstrated that subjects' responses to surveys about their built environment can change in response to their awareness of new technologies or techniques of building design (Saegert & Winkel, 1990). This was demonstrated most clearly in the Heerwagen and Zagreus (2005) study mentioned earlier, where subjects expressed overall satisfaction with their building environment because of their awareness that it was a LEED certified green building. The results of these earlier studies were used in introducing an experimental component in this study in addition to the survey questionnaire.

Kanizsa's Triangle

This thesis adapts the optical illusion of the Kanizsa Triangle (Kanizsa, 1976) to highlight the uncertain nature of the perceived benefits of visual design elements. The subjective Kanizsa triangle is formed of two triangles, one of which appears to be a white, equilateral triangle formed by the illusory contours of three circular sectors (i.e., Pac-man shapes or omnomnomagons) (Figure 1).

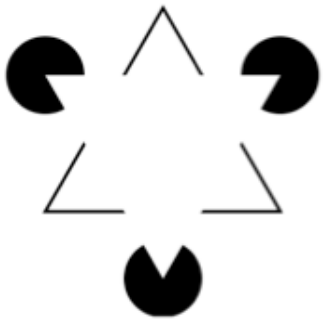


Figure 1: Kanisza's Triangle
Source: Kanizsa, 1976, p. 156

The illusory triangle has no physical existence in this illustration; it appears only because of the brain's habit of making connections and creating familiar simple objects. The aim in using an optical illusion as part of the conceptual framework of this thesis is to emphasize the subjectivity and uncertainty of the responses that were received and allow us to consider the interrelationship between "visual design elements," "psychological well-being," and "workplace satisfaction" vis-à-vis "looking good," "feeling better," and "doing great." (Figure 2).

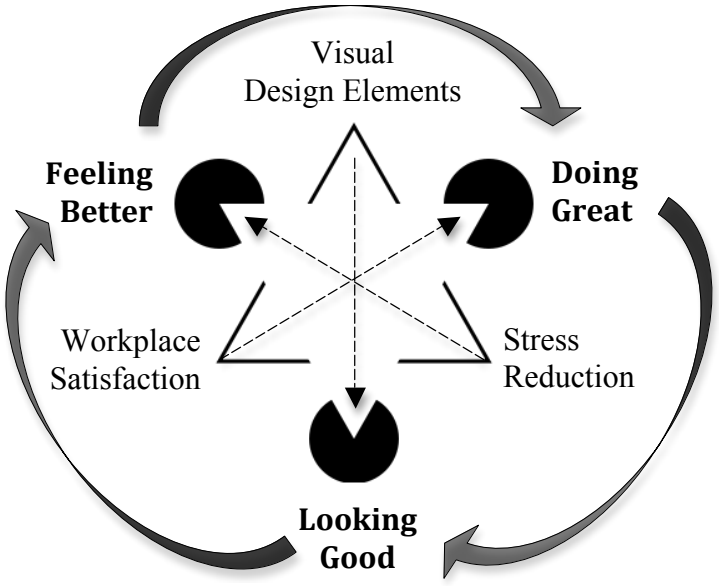


Figure 2: Proposed framework of study of workplace environment

This study hypothesized that "what one sees" influences "how one feels" and by extension "how one works." As Cassidy (1997) explained, *perception* is how individuals come to understand and deal with their immediate environment. The Kanizsa illusion

works together with environmental psychological theory to successfully provide a needed structure for examining "how we become aware of information in our environment, how we process that information, and how we give meaning to that information which eventually lead us to respond to it in one way or another" (Cassidy, 1997, p. 13).

Hypotheses

There are a few concerns about studying visual design elements in the workplace environment: 1) workers may not notice the presence of visual design elements (e.g., artwork and color) around their workstations or may not be able to see these design elements due to their physical locations; 2) the effect of visual design elements on psychological or emotional states may not last as participants become habituated to the presence of the design elements – the diminishing of a psychological or emotional response to frequently repeated design elements.

To better understand the human-environment relationship, the investigator tested the hypothesis that occupants may experience actual benefits if they are *informed* that certain visual design elements affect them in a positive way. Although the study follows the traditional methodology for comparable studies (i.e., using self-assessment POE questionnaire to gather information), it also incorporated an experimental element, randomly assigning subjects to treatment or control groups and comparing the results of their responses to the questionnaire.

The present study proposed the following hypotheses:

H1. The presence of the identified visual design elements (e.g., color, artwork, and window view) contributes to the workplace satisfaction of health care professionals.

H2. Participants who are informed that the identified visual design elements affect them positively (the treatment group) have higher workplace satisfaction than those who are not so informed (the control group).

The hypothesized relationship among variables is depicted in the following research model (Figure 3).

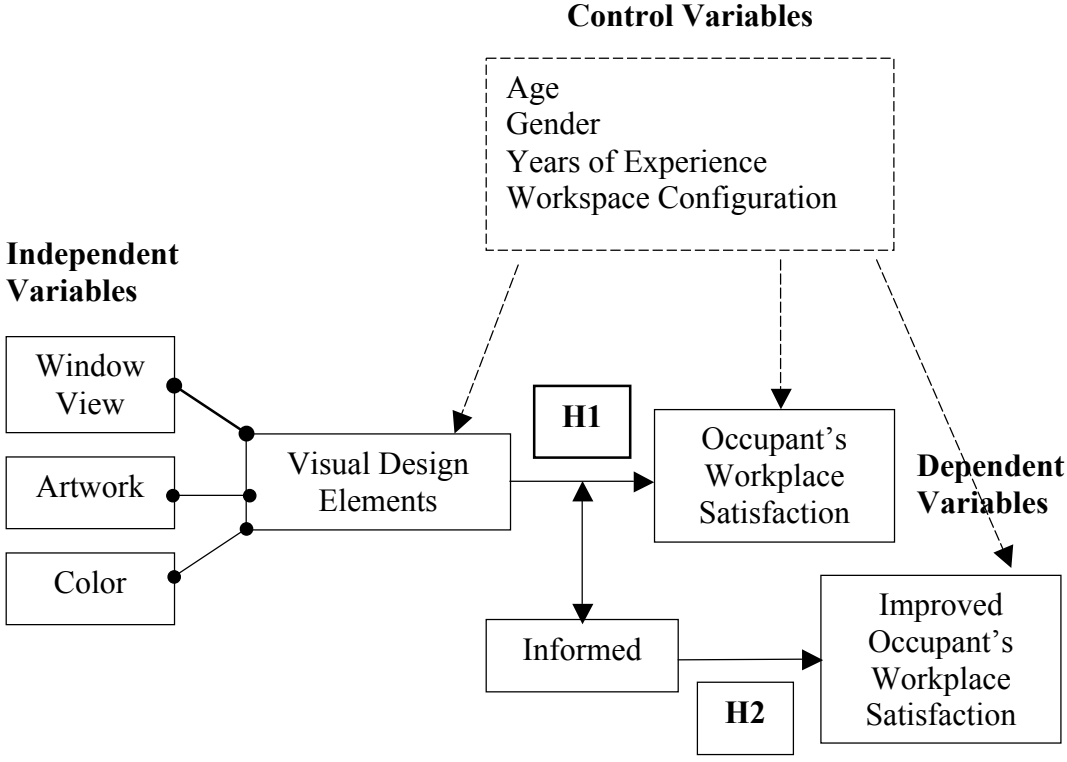


Figure 3: Proposed research model of hypothesized relationships among variables

CHAPTER THREE: METHODS

This chapter provides a description of the research methodology. The first section, "Data Collection," describes setting and sample population, instrument, procedure, and dependent variables. "Data Preparation" explains statistical strategies used in this study. This chapter also addresses limitations of this study.

Data Collection

This study collected quantitative data to examine health care professionals' perceptions of their workplace environment. Quantitative data were preferred for this study because it not only allowed a large amount of data to be collected in a short period of time, it also allowed for cross examination between variables (Creswell, 2013). In addition to quantitative survey questions, two open-ended questions were included to capture participants' own words about their workplace environment. The Internet based, free and customizable survey tool – SurveyMonkey – was used for data collection.

Setting and Sample Population

This is an observational cross-sectional study design. The data were collected from a sample of subjects at one point in time (Motulsky, 2013). Data were collected from one Medical Office Building (MOB) located in the Northwest region of the United States. This 5-story, 111,000 square foot building, designed to achieve the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Gold status,

is part of the 15-acre medical center campus that also includes a 128-bed hospital inpatient tower, a dental office building, emergency department, and a patient/visitor parking garage. The building was completed in May 2013 and opened in August 2013 (Figure 4).

Figure 4: Exterior view of the study site
Source: DiNardo A. (2013, November 1), Photo: Cridland S.

The target population of this study was health care professionals working in MOBs in the United States. The study sample was a convenience sample that selected from subjects who worked in the above-mentioned MOB. In total, there were 224 subjects recruited for this study, which included 84 providers (MDs and affiliated clinicians) and 140 staff (non-MDs, staff, medical assistants, nurse practitioners, etc.). It was not feasible to randomly select health care professionals from the entire population.

The selected study sample, however, was considered to be representative of the health care professionals in the target population.

The size of the study sample was calculated based on the formula $N = 2C (SD/w)^2$ (Motulsky, 2013, p. 221): N represents the sample size, C is based on the significance level as shown in Table 1. The estimated mean difference between treatment and control groups, based on the literature review, was 0.5 (i.e., half point on a 7-point Likert scale) and the standard deviation was 1.0 (i.e., one full point on the 7-point Likert scale). For a standard 80% power and a 5% significance level, C = 7.8. The calculation for the sample size for each group would be: $N = 2C (SD/w)^2 = 2 * 7.8 (1.0/0.5)^2 = 62$. Thus, 62 participants per group would be needed to compare the mean difference of 0.5 between the treatment group and control group when the standard deviation (SD) for the workplace satisfaction is about 1.0 and follows the typical power and significance level. The present study would require a minimum of a 55% response rate for each group.

Table 1: Multiplier (C) used when computing required sample size
(Source: Motulsky, 2013, p. 221)

Power	**Significance Level or α (two-tailed)**			
	0.1	0.05	0.01	0.001
50%	2.7	3.8	6.6	10.8
80%	6.2	7.8	11.7	17.1
90%	8.6	10.5	14.9	20.9
95%	10.8	13.0	17.8	24.4
99%	15.8	18.4	24.0	31.5

After initial approval from the organization, questionnaires were distributed to all subjects in the facility via Internet. The main reasons for selecting this individual building as a satisfactory sample for the study were twofold. First, observation by the researcher documented that artwork, colors, and interior windows were obviously present throughout the interior space, including both patient and staff areas (see Figure 5). Second, the building was finished and occupied just over a year ago; it was considered an ideal timeline for conducting a POE survey.

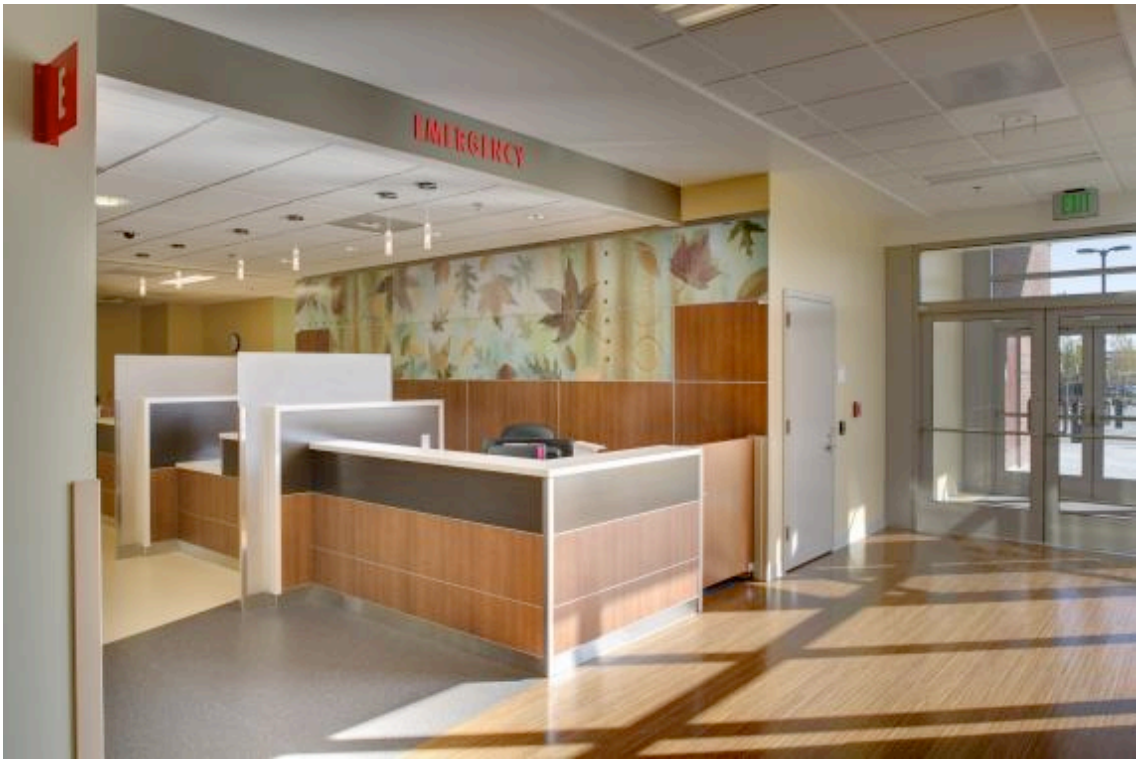


Figure 5: Staff work areas with artwork
Source: DiNardo A. (2013, November 5), Photo: Cridland S.

Instrument

This thesis study relied upon a quantitative survey instrument, i.e., Post-Occupancy Evaluation (POE). A questionnaire is a preferred type of data collection procedure for this study due to the benefits of economic and decreased turnaround time (Creswell, 2013). The questionnaire was designed to be distributed at one specific time frame and the questions were designed to be answered by each participant once only. The data collection was Internet-based (SurveyMonkey) and self-reported for ease in distributing and collecting data. The full questionnaire took approximately 10 minutes to complete.

The proposed POE questionnaire, created for the purpose of evaluating health care professionals' workplace satisfaction in relation to visual design elements, was adapted and revised from questions developed by both the Center for Sustainable Building Research (CSBR) (e.g., B3-SPOES) at the University of Minnesota and the Center for the Built Environment (CBE) at UC Berkeley for studying sustainable office buildings. The instrument was developed based on a norm-referenced framework and is designed to measure the "differences among people who possess differing quantities of a characteristic can be portrayed along a continuum of values" (Pett, Lackey, & Sullivan, 2003, p. 5).

The first group of questions was intended to identify demographic information about the participants, i.e., age, gender, years of work experience, current job position, whether the participants were able to look out a window from their primary workspace,

and how they felt about the window substitutions in the absence of an outdoor window view. Studies have shown that these factors influence individuals' attitudes and their expectations toward a workplace environment (Manning, 1970; Sadatsafavi *et al*., 2013; Wells, 1970). They were viewed as control variables and were analyzed by a multiple regression model.

The second group of questions was developed based on a review of the current literature and covered selected topics about the designed workplace environment. The principal questions were constructed to measure "the degree of positive or negative effect associated with some psychological object" (Wells, 1970, p. 485-6), i.e., participants were asked to rate each listed design aspect in terms of preference in a 7-point rating scale, ranging from -3 (very dissatisfied) to 3 (very satisfied). Two open-ended questions were developed to allow individuals to express their opinions about their workplace environment.

All instructions and questions were carefully worded to ensure that they would be clearly understood and unambiguous so that every respondent would be able to answer every question (unless instructed otherwise) independently. The questionnaire was initially pre-tested on a small sample of people to determine the length of time required to complete the questionnaire, and to learn whether that the respondents would have any problem understanding the questionnaire. Based on the feedback and comments from the pre-test, the questions were revised and adjusted to reduce the numbers of questions, as well as to improve clarity and readability. To give one example: the question about

window substitution was initially designed as an open-ended question but was revised into a 7-scale question in order to restrict the number of possible responses. The two open-ended questions were added to allow respondents to express their opinions or ideas in their own words. The revised questionnaire was then entered in SurveyMonkey and ready to be sent out.

The logical sequence of the questions followed an appropriate psychological order. The importance of the order was "to lead the respondent into the questionnaire gently, to open with simple and direct questions about pedestrian topics, and then to move on to the ones requiring thought and judgment" (Wells, 1970, p. 486-7). In this case, for example, the first group of questions dealt with basic information about the respondent. Subsequent questions in turn interrogated respondent's personal opinions and/or attitudes. The final portion of the questionnaire asked respondents to use their own words to describe their particular views or judgments (see Appendix B).

Procedure

This double-blind, randomized, controlled study was designed to more accurately measure whether the effects, or lack of effect, of visual design elements were shaped by individuals' conscious or subconscious expectations or assumptions regarding what that effect should be. Two online survey questionnaires, labeled Group A and Group B, were created. The participants were divided randomly into the treatment and control groups: the treatment group received the Group A questionnaire and the control group received the Group B questionnaire. The difference between these two questionnaires was that

Group A was provided with a "Fact Sheet" which was a single page containing information regarding the health benefits of visual design elements, which they were asked to read prior to the survey (see appendix A). Group B did not receive the "Fact Sheet." Other than the "Fact Sheet," both groups had identical consent forms and questions. The present study received an exemption from the University of Minnesota Institutional Review Board (IRB). The consent form included the approved study number from the IRB, study background and procedure, and contact information about the researcher.

The study was conducted between February 3rd and February 27th, 2015 over duration of 19 working days. On February 3rd, an email containing the survey link was sent by a senior architect who works for the organization to all health care professionals in the MOB using the organization's internal mailing system. The architect also sent out a second reminder email on February 11th and a final reminder email on February 23rd. Subjects were encouraged to complete the questionnaire during work hours.

Variables

The independent variables of the study were the visual design elements: window view, artwork, and color. Survey question number 6—"Can you look out a window from your primary workspace?"—and survey question number 7—"In the absence of an outdoor window view, how do you feel about the substitutions?"—were designed to assess these independent variables.

The dependent variable was occupants' workplace satisfaction. Nine items under question number 8 were used to measure workplace satisfaction in this study: "How satisfied are you with the following design aspects in your workspace?" Among the nine items listed, four were directly linked to the proposed research questions (i.e., the colors on walls, artwork, amount of daylight exposure, and quality of exterior window views) and were analyzed statistically. The remaining five items included three that were indirectly linked to the "perceived" aspects of the workplace environment (i.e., amount of overhead lighting, quality of overhead lighting, and overall cleanliness and maintenance) and two that were unrelated (i.e., workplace furnishings and sound privacy). These items were designed to function as diversions to minimize the degree to which the employees might attempt to provide certain answers they believed were pursued by their superiors or the investigator (i.e., Hawthorne effect).

One open-ended question regarding a specific visual design element, color, was incorporated in the survey questionnaire: "If you could get rid of one color in your workplace, what would it be? Why?" This question was designed to take into consideration whether participants were even aware of the presence of visual design elements or whether the effect of visual design elements would last as participants become habituated to the presence of visual design elements (i.e., novelty effect). The responses to this question were converted into itemized list with counts and percentage, and compared with the responses from the quantitative questionnaire.

Data Preparation

Data Screening and Preparation

Preliminary analyses included screening data for potential outliers, missing values, and calculating response rate. Data preparation involved entering the data into the computer (e.g., Excel) for records, and developing and documenting a database structure that integrated the various measures.

Statistics Techniques

The data were analyzed by using the SPSS version 22.0. Descriptive statistics such as measures of center (i.e., mean), measures of spread (i.e., standard deviation), and graph (i.e., histogram) were used to summarize continuous quantitative data. A randomization hypothesis test was used to test for differences in means between the treatment and control groups. Open-ended survey responses were entered into the same Excel file where the quantitative data were stored. The investigator sifted through all the quotes and organized the information into themes based on the responses received. The data were then reported in percentage of total responded answers and used to compare with the quantitative data.

For the randomization hypothesis test, the assumption (i.e., null hypothesis) was that there was no sample mean difference in workplace satisfaction between those who were informed that visual design elements affect them positively (treatment group) and those who were not informed (control group). The prediction (i.e., alternative hypothesis)

was that the treatment group would have higher workplace satisfaction than the control group. A 95% confidence interval (CI) of the sample mean difference between the treatment group and control group was calculated. A *p*-value was also calculated to support the conclusion made by the 95% CI to further test the statistical significance of the mean difference between the study groups.

Limitations

The results from the present study should be viewed with caution due to the exploratory nature of the study. The findings from this study could not be generalized beyond this study due to the following limitations. First, although the measurement instrument was created and modified based on validated existing instruments, this instrument has never been used in other studies. In addition, it did not contain questions that measure occupants' stress levels or questions that measure occupants' overall satisfaction with their workplace. Because of the lack of information, it is difficult to draw connections between the independent variables (i.e., visual design elements) and the dependent variable (i.e., occupants' workplace satisfaction). The descriptive statistics (i.e., mean and standard deviation) for each variable provided basic features of the data but not enough to obtain information to answer the research questions completely or in-depth. Although the open-ended questions provided valuable information and were useful for comparing quantitative data, no statistical analysis could be performed to draw a

connection between results of the quantitative survey questionnaire and answers provided to open-ended questions.

Second, insufficient sample sizes due to low survey response rate resulted in less than ideal data for statistical analysis. Because of the low response rate, the results of any statistical analysis could be skewed due to volunteer bias, i.e., those who did respond might be different in some ways from those who did not respond, or non-respond bias, i.e., the non-responders might be different from the responders in some way. Both would result in a sample that might not be representative of the population of interest. For example, the demographic factors such as age, gender, and years of work experience were unable to be used for statistical analysis in the present study due to the lack of diversity of the collected data, i.e., the majority of the participants were older, female, and had more than 11 years of work experience.

Third, the participants were self-reporting their satisfaction levels with regards to their workplace environment during the specific time frame. There is no way of knowing if their responses were truthfully reflecting their opinions at the time they were filling out the questionnaire. Although the responses from the present study presented distinctive variance between different questions, it could be very much a momentary reaction since majority of the questions were asking for subjective opinions.

Fourth, the lack of concrete benefits in the "Fact Sheet" (i.e., absence in reporting specific percentage of probability effects of certain visual design elements) may have resulted in the lack of difference between the treatment and control groups. The author

was unable to locate any concrete evidence definitively stating the positive effects of visual design elements in relation to occupants' workplace satisfaction and was reluctant to fabricate artificial evidence. Consequently, the impact of the information provided on the "Fact Sheet" may have been inadequate to produce any measurable difference in participants' attitudes towards their workplace environment.

Finally, this study did not address Hawthorne effect, i.e., the degree to which workers attempt to provide the answers they believed are sought by their superiors or the investigator. The investigator did incorporate several questions that were not directly related to the study variables in order to avoid making the intent of the study obvious. She also incorporated open-ended questions to encourage participants to express their opinions freely. Most of the answers however were still subjective opinions.

CHAPTER FOUR: RESULTS

This chapter provides the research findings from both statistical analysis of quantitative variables and interpretations of the open-ended questions in examining participants' workplace satisfaction in relation to visual design elements. The first section, "Preliminary Data Analysis" calculates the validity and reliability of the instrument as well as the distribution of the data to confirm whether the sample is representative of the target population. "Statistical Analysis" contains the results of the primary data analyses conducted to test the hypothesized relationships proposed in Chapter two.

Preliminary Data Analysis

The preliminary data analysis describes steps taken to ensure that the sample data meet basic assumptions before statistical analysis.

Validity and Reliability of Instrument

Most questions in the survey asked about respondents' subjective experiences, i.e., face validity. Face validity, as defined by Craighead and Nemeroff (2004) is the "appropriateness, sensibility, or relevance of the test and its items as they appear to the person answering the test" (p. 360), and thus is often classified as superficial. However, this does not mean that face validity has no value, as stated in Wells's (1970) study, because respondents were "certain of complete anonymity" and "the effective tone of the

questions was fairly or completely neutral," therefore "there is no reason why the face validity of the replies should be seriously questioned" (p. 486).

To test for reliability of the survey instrument, i.e., the ability of the measure to produce the same results under the same conditions (Creswell, 2013), a reliability analysis in SPSS showed that all scales had good internal consistency reliability with Cronbach's alpha values > .70. The complete Cronbach's alpha values for the questionnaire are shown in Table 2.

Table 2: Descriptive and reliability statistics of continuous variables

	Treatment (N≤53)		**Control (N≤30)**	
Variables	**Mean (SD)**	**Cronbach's alpha**	**Mean (SD)**	**Cronbach's alpha**
Overall Cronbach's Alpha		.790		.864
Window substitutions				
Artwork	1.56 (1.42)	.772	1.56 (1.73)	.847
Color	1.67 (1.45)	.767	1.40 (1.71)	.846
Interior Window	0.75 (1.89)	.811	0.76 (2.26)	.869
Workplace satisfactions				
Furnishings	1.47 (1.31)	.773	0.94 (1.91)	.853
Color	1.51 (1.28)	.778	1.16 (1.68)	.846
Artwork	1.06 (1.81)	.786	0.90 (1.99)	.840
Amount of overhead	1.45 (1.64)	.777	1.68 (1.45)	.853
Quality of overhead	1.11 (1.80)	.776	1.39 (1.50)	.851
Sound privacy	-0.04 (2.26)	.782	-1.03 (2.17)	.886
Amount of daylight	0.00 (2.33)	.746	-0.16 (2.46)	.840
Quality of window view	-0.38 (2.18)	.748	-0.42 (2.62)	.838
Cleanliness & maintenance	0.86 (1.56)	.774	0.70 (1.88)	.859

The value indicated how stable the response was. For instance, the treatment group has an overall reliability of 0.79, indicating that there is a 0.38 error variance (random error) in the scores (0.79 x 0.79 = 0.62; 1.0 – 0.62 = 0.38) (Kline, 1994, p. 42). Similarly, there is a 0.26 error variance in the control group. A higher alpha does not always mean a higher degree of internal consistency. In this case for instance, the treatment and control groups should have identical or at least similar alpha because they used the exact same survey instrument. However, the calculated Cronbach's alpha values vary between these two groups, more specifically, the Cronbach's alpha values for individual items in the control group were higher compared to the items in the treatment group (see detailed list in Table 2). Note that the measurement of the internal consistency of a scale is also inter-related within a test, in general, a Cronbach's alpha value is considered good if it is ≥ .70 (Field, 2009).

It is also important to point out that internal consistency normally would be determined before a study to ensure validity (Kline, 1994). In this case, it was calculated after the study was completed. The reason was that the questionnaire was revised and adjusted after the pre-test based on the participants' feedback and comments. Since the numbers of the questions and the content in some of the questions were not the same, the investigator recalculated the Cronbach's alpha values based on the revised questionnaire.

Normal Distribution

Before conducting the statistical analysis, the data in the present study were presumed to be sampled from a population that follows a normal distribution (i.e.,

Gussian distribution). The notion was that if the samples were large enough, the distribution of means would approximate a symmetrical and bell-shaped distribution to allow for statistical analysis (Motulsky, 2013). There are two ways data could deviate their distribution from normal: lack of symmetry (skew) and lack of pointyness (kurtosis) (Field, 2009). In a normal distribution, the values of skewness and kurtosis would be zero. Due to sampling variable however, most data could only be assessed for approximately normal distribution (Motulsky, 2013).

Descriptive statistic skewness and kurtosis, as well as *p*-value, can all be obtained by using SPSS software but the results are not necessary useful or practical. Samples from Gaussian distributions for example do not always look Gaussian, and *p*-value would always be small with large sample sizes (Motulsky, 2013). It is satisfactory to assume that the data in the present study were sampled from a Gaussian distribution and therefore it is appropriate to be used for statistical analysis.

Sample Size

The calculated sample sizes required 62 participants per group to make the appropriate comparison between the treatment and control groups, i.e., mean difference equals 0.5, standard deviation (SD) to be 1.0, with 80% power and 0.05 significance level. Neither group however reached the numbers of desired participants despite multiple reminders. The high spread of data might be understood as resulting from insufficient sample size.

Anticipated low response rates were taken into consideration at the beginning of the survey instrument development stage. The number of survey questions was dramatically reduced based on feedbacks from the pre-testers in order to reduce the amount of time required to complete the questions. The length of completion time was reduced from 20 minutes to 10 minutes to improve anticipated response rate, although this effort was ultimately unsuccessful.

Statistical Analysis

This study examined whether the presence of identified visual design elements impact health care professionals' workplace satisfaction. The study also investigated whether learned knowledge (cognitive expectations) about visual design elements might increase health care professionals' workplace satisfaction. The t-test indicated that identified visual design elements might have a potential effect on health care professionals' workplace satisfaction. The hypothesis testing on the other hand, showed no statically significant difference between the treatment and control groups (zero was included within the null hypothesis).

Study Participants Characteristics

A total of 224 health care professionals who have workstations in the chosen building were selected for this study. The senior architect who was responsible for sending out the Internet SurveyMonkey links randomly assigned participants to either

treatment group or control group. Neither the participants nor the investigator knew which group was receiving a particular treatment.

The survey instrument was sent via organization internal email source to each participant. All subjects were given information about the study objective and written consent. Ninety-three of 224 participants responded to the questionnaire between the 3rd and the 27th of February, 2015. The overall response rate was 41.5%. The response rate for Group A was 51.8% and for Group B was 31.2%. After the preliminary data screening for potential outliers and missing values, there were 53 subjects in the treatment group and 30 subjects in the control group who were included in the analysis (Figure 6).

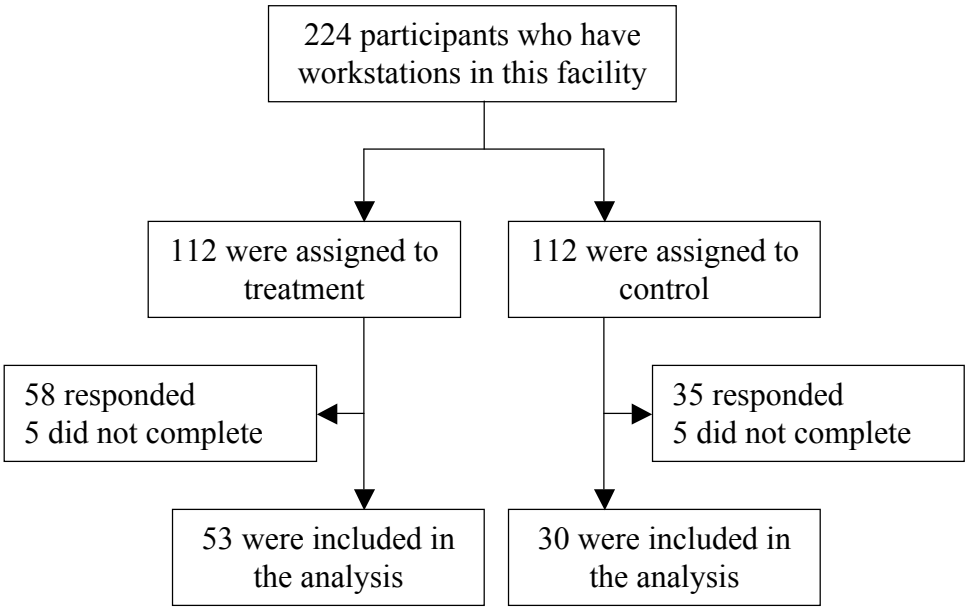


Figure 6: Study participants

The basic characteristics of the participants who responded to the survey is shown in Table 3. Despite the unequal sample sizes of the treatment group and control group, there were no statistically significant differences in terms of demographic variables (i.e., age, gender, and years of work experience), accessibility to the exterior window views, and opinions about window substitutions between the participants in these two groups.

Table 3: Characteristics of the study participants

Variable	**Treatment Group (N≤53)**	**Control Group (N≤30)**
Age*† - yr	47.9 ± 9.9	45.2 ± 11.5
Gender† - no. (%)		
Female	43 (82.7)	24 (80.0)
Male	9 (17.3)	6 (20.0)
Years of Work Experience† - no. (%)		
1-5 yr	1 (1.9)	2 (6.6)
6-10 yr	6 (11.3)	5 (16.7)
More than 11 yr	46 (86.8)	23 (76.7)
Personal Workspace Configuration† - no. (%)		
Enclosed-Private	10 (19.2)	4 (13.3)
Enclosed-Shared	12 (23.1)	14 (46.7)
Workstation w/partitions	19 (36.5)	6 (20.0)
Workstation w/o partitions	11 (21.2)	6 (20.0)
Visual Access to Window† - no. (%)		
Yes	21 (40.4)	14 (46.7)
No	31 (59.6)	16 (53.3)
Attitudes toward Window Substitutions*†		
Artwork	1.56 ± 1.42	1.56 ± 1.73
Color	1.67 ± 1.45	1.40 ± 1.71
Interior Window	0.75 ± 1.89	0.76 ± 2.26

* Plus-minus values are means ± SD.

† Sampling units vary in different variable categories.

The majority of the participants in the treatment group and the control group was female (83% and 80%, respectively) and had more than 11 years of work experience (87% and 77%, respectively). The mean age of the participants was 47.9 (± 9.9) years in the treatment group and 45.2 (± 11.5) years in the control group, respectively.

Table 4: Age groups of the study participants

Variable	Treatment (N=48)	Control (N=29)
Age – no. (%)		
20 - 29	2 (4)	3 (10)
30 - 39	6 (12)	7 (23)
40 - 49	23 (45)	11 (37)
50 - 59	12 (25)	4 (13)
60 - 69	7 (14)	5 (17)

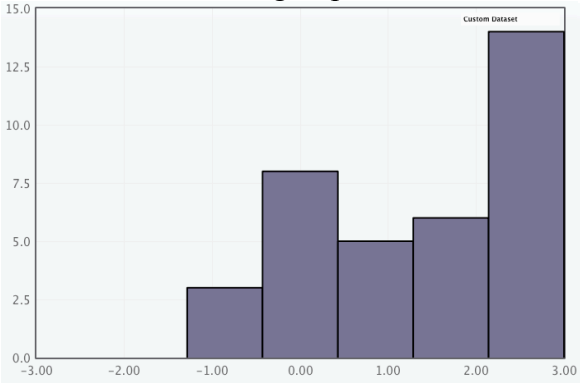
The majority of the participants in the treatment group and the control group was female (83% and 80%, respectively) and had more than 11 years of work experience (87% and 77%, respectively). The mean age of the participants was 47.9 (± 9.9) years in the treatment group and 45.2 (± 11.5) years in the control group, respectively. To better understand the age distribution of the participants in this sample population, an age table was created (see table 4). High percentage of participants was in the 40 and older group (i.e., 84% and 67%, respectively). Age was a continuous variable and thus was reported with standard deviation (±SD). Note that two numbers were removed from this calculation – one outlier was identified in the control group (5 years old) and one invalid number was identified in the treatment group (i.e., 35-55 years old). In addition, four

participants did not provide answer in the treatment group, resulting in only 48 responses in the treatment group and 29 responses in the control group.

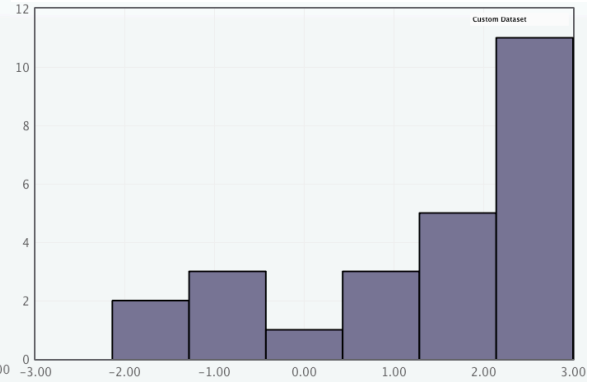
In the personal workspace variable, a higher percentage of participants in the control group worked in private or shared offices than those in the treatment group (60% and 42%, respectively), and a higher percentage of participants in the treatment group worked in workstations with or without partitions than those in the control group (58% and 40%, respectively). Accessibility to exterior window view seemed to correspond with participants' workplace settings since 42% of participants in the treatment group worked in either private offices or shared offices and 40% of participants in the same group reported they had window access. Similar parallel association could also be seen in the control group (i.e., 60% of participants worked in offices and 47% had window access). However, the results from the calculation of the chi-square showed *p*-values were larger than 0.05 in both the treatment and control groups (0.69 and 0.30, respectively). This suggests that window access was independent of workspace configurations in this sample population.

The majority of participants in this sample expressed positive attitudes toward artwork and color as window substitutions (i.e., left-skewed). The distributions of variables were presented in histograms, where the vertical axis showed frequency and the horizontal axis showed satisfaction (see Figure 6). Fewer participants marked "dissatisfied" in both artwork and color variables in either group compared to interior window.

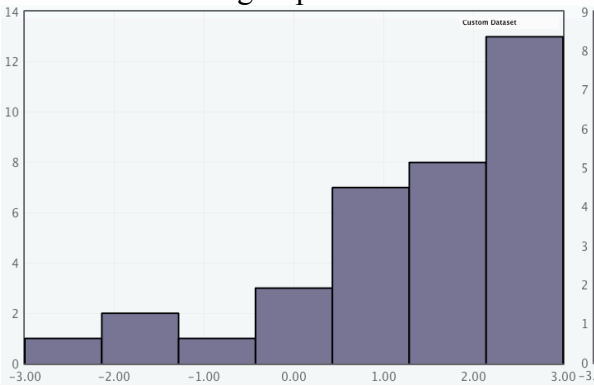
Artwork –Treatment group



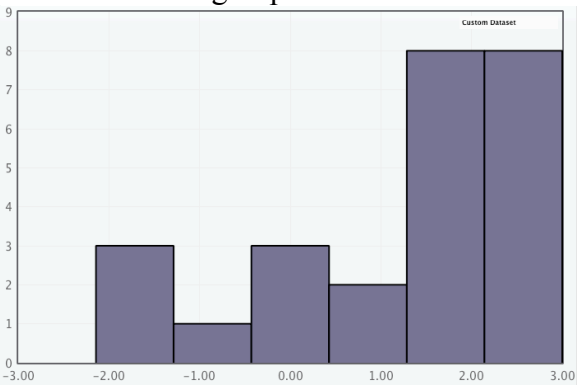
Artwork – Control group



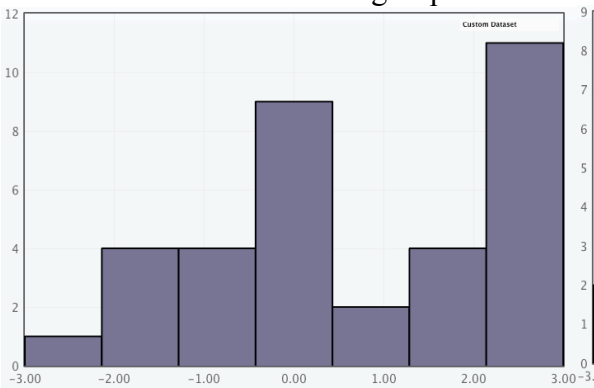
Color –Treatment group



Color – Control group



Interior window –Treatment group



Interior window – Control group

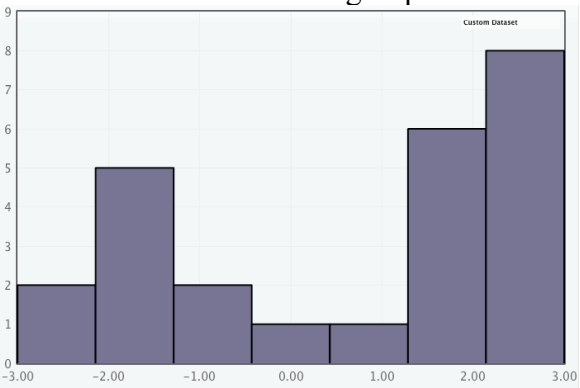


Figure 7: Histograms of window substations between treatments groups

The means for each window substation variable were either identical or similar in the treatment and control groups, i.e., both were 1.56 for artwork; 1.67 and 1.40 for color, respectively; and 0.75 and 0.76 for interior window, respectively. The opinion regarding window substitutions was also a continuous variable, thus the data were reported with standard deviation (±SD) (see Table 3).

The job position variable was not included in the above analysis due to the broad diversity in positions reported. The overall job position list is shown in Table 5. Except for the listed positions, i.e., physician, medical assistant, and nurse practitioner, high percentage of participants reported their positions under "other" in both treatment and control groups (i.e., 59% and 63%, respectively). The three highest percentages listed in this sample were medical assistant (28% and 17%, respectively), physician (13% and 17%, respectively), and registered nurse (11% and 17%, respectively) in the treatment and control groups.

Some job positions look alike but had different responsibilities. For instance, a medical assistant helps with taking patients' vitals and does not require a license; but a physician assistant can perform many of the same duties as a physician. Different titles may have different licensing requirements, for instance, licensing requirements and scope of practice increase from LPN (Licensed Practical Nurse) to RN (Registered Nurse) to RPN (Registered Practical Nurse).

Table 5: Job positions of the study participants

Job Positions - no. (%)	Treatment (N=53)	Control (N=30)
Administration	-	1 (3.3)
Administrative assistant	-	2 (6.7)
ADA (Assistant Department Administrator)	1 (1.9)	1 (3.3)
Audiologist	-	1 (3.3)
Cardiac sonographer	1 (1.9)	-
Executive	1 (1.9)	-
Imaging assistant	2 (3.8)	-
LPN (Licensed Practical Nurse)	2 (3.8)	1 (3.3)
Manager	4 (7.5)	2 (6.7)
Medical assistant	15 (28.3)	5 (16.7)
Medical coordinator	-	1 (3.3)
Nurse midwife	1 (1.9)	-
Nurse Practitioner	1 (1.9)	3 (10.0)
Orthopedics tech	1 (1.9)	-
Pharmacist	3 (5.7)	3 (10.0)
Phlebotomist	2 (3.8)	-
Physician	7 (13.2)	5 (16.7)
Physician assistant	1 (1.9)	-
Professional	1 (1.9)	-
RN (Registered Nurse)	6 (11.3)	5 (16.7)
RN team lead	1 (1.9)	-
RPSGT (Registered Polysomnographic Technologist)	1 (1.9)	-
Surgery scheduler	1 (1.9)	-
Technologist-team lead	1 (1.9)	-

Descriptive Statistics

The descriptive statistics for the measured variables such as mean and standard deviation (SD) are reported in Table 6. It appeared that participants were satisfied with

color (1.51 and 1.16, respectively) and artwork (1.06 and 0.90, respectively) but dissatisfied with amount of daylight (0.00 and -0.16, respectively) and quality of exterior window views (-0.38 and -0.42, respectively) in the treatment and control groups. The SD describes the spread of the values; the higher SD indicates that the values were more widely dispersed. In the present study, SD was considered high (ranging from 1.28 to 2.62) among the variables, showing that the participants' subjective perceptions of their physical work environment varied significantly. The wide variability arguably might be attributed to the small sample sizes. According to Motulsky (2013), however, while large sample sizes could quantify the variability more precisely and more accurately, more samples would not change the variability among the values.

Table 6: Descriptive statistics of variables

	Treatment (N≤53)		**Control (N≤30)**	
Variables	**Mean**	**SD**	**Mean**	**SD**
Workplace satisfactions				
Color	1.51	1.28	1.16	1.68
Artwork	1.06	1.81	0.90	1.99
Amount of daylight	0.00	2.33	-0.16	2.46
Quality of window view	-0.38	2.18	-0.42	2.62
Furnishings	1.47	1.31	0.94	1.91
Amount of daylight	0.00	2.33	-0.16	2.46
Quality of window view	-0.38	2.18	-0.42	2.62
Cleanliness & maintenance	0.86	1.56	0.70	1.88

The interpretation of the scale intervals was based on the study conducted by Heerwagen and Zagreus (2005), i.e., the scores were given either negative (dissatisfied) or positive (satisfied) numbers with a neutral response being 0. The means were fairly consistent in each variable between the treatment and control groups despite their difference in sample sizes. The overall summary of sample means among variables is shown in Figure 6. Variables such as furnishings, amount and quality of overhead light, sound privacy, and cleanliness and maintenance included in this figure were used for reference only.

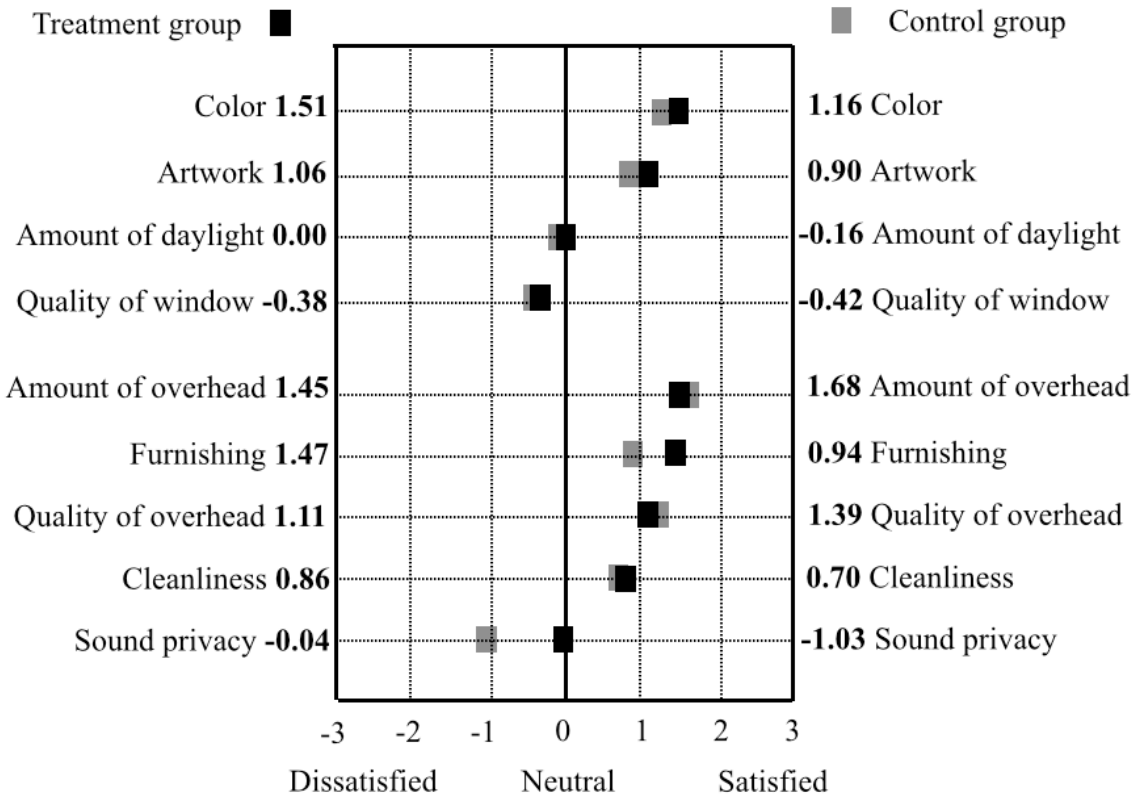


Figure 8: Comparison of sample means among variables

Due to the widely dispersed values, it might be practical to calculate percentage of response for each variable in terms of satisfactory and unsatisfactory counts. The overall comparison is shown in Table 7. The data showed visible trends that a high percentage of participants in the treatment and control groups responded positively to color (81% and 60%, respectively) and artwork (64% and 60%, respectively). The variables of daylight and window view, on the other hand, showed a range of responses between dissatisfied and satisfied, e.g., 43 % of participants in the treatment group reported dissatisfaction with window view while 38% of participants in the same group reported satisfaction. It was likely that the responses regarding the daylight and window view variables were associated with whether the participants had visual access to exterior window.

Table 7: Response counts and percentages of individual variable

	Treatment (N=53)			**Control (N=30)**		
Variables	**Dissatisfied**	**Neutral**	**Satisfied**	**Dissatisfied**	**Neutral**	**Satisfied**
Workspace Satisfaction - no. (%)*						
Color	2 (4)	8 (15)	43 (81)	7 (23)	5 (17)	18 (60)
Artwork	7 (13	12 (23)	34 (64)	8 (27)	4 (13)	18 (60)
Daylight	20 (38)	5 (9)	28 (53)	12 (40)	5 (17)	13 (43)
Window View	23 (43)	10 (19)	20 (38)	15 (50)	2 (7)	13 (43)
Furnishings	3 (6)	9 (17)	41 (77)	9 (30)	3 (10)	18 (34)
Amount of overhead	6 (11)	4 (8)	43 (81)	3 (10)	1 (3)	26 (87)
Quality of overhead	8 (15)	5 (9)	40 (75)	4 (13)	5 (17)	21 (70)
Sound privacy	20 (38)	6 (11)	27 (51)	20 (67)	3 (10)	7 (23)
Cleanliness	8 (15)	12 (23)	33 (62)	8 (27)	4 (13)	18 (60)

* Dissatisfied is the percentage of the negative responses (-3 to -1), satisfied is the percentage of the positive responses (1 to 3), and neutral is the percentage of those who responded in 0.

To test whether an exterior window access has significant influence on participant's workplace satisfaction, an unpaired *t*-test could be used to test the mean difference. In this study, the means were significantly different because the calculated *t* values exceeded the critical values in all four variables in the treatment and control groups (see Table 8). P-values were very small among all variables (color variable <0.05, artwork, amount of daylight, and quality of window view variables <0.001), indicating that the mean difference for the workplace satisfaction between participants who had window views and those who did not is significantly different.

Table 8: Unpaired t-test for individuals with and without window access

Treatment Variables	With window access (N=22)	No window access (N=31)	*t score*	*DF*	Critical value	*p*-value
Workspace Satisfaction						
Color	1.95	1.19	2.332	51	1.676	0.0118*
Artwork	1.95	0.45	3.454	51	1.676	0.0006***
Daylight	2.05	-1.45	8.955	46	1.679	0.0001***
Window View	1.45	-1.77	7.812	49	1.677	0.0001***

Control Variables	With window access (N=14)	No window access (N=16)	*t score*	*DF*	Critical value	*p*-value
Workspace Satisfaction						
Color	1.86	0.63	2.121	28	1.701	0.0214*
Artwork	1.86	0.06	2.759	51	1.676	0.0054***
Daylight	2.00	-2.06	7.750	28	1.701	0.0001***
Window View	1.57	-2.19	5.416	27	1.703	0.0001***

*$p < 0.05$, **$p < 0.01$; ***$p < 0.001$

Hypothesis Testing

Hypothesis testing means to take the effect of sampling variability into account and to provide a standardized decision-making process to test a claim (Motulsky, 2013). In the present study, the null hypothesis was that there was no sample mean difference in workplace satisfaction between those who were informed that visual design elements affected them positively (treatment group) and those who were not informed (control group). The alternative hypothesis was that the treatment group would have higher workplace satisfaction than the control group. A use of a one-tail *p*-value was appropriate in the present study due to the alternative hypothesis that assumed the treatment group would have higher workplace satisfaction than the control group. The *p*-value for the hypothesis testing assumes that the null hypothesis is true and that any observed difference is simply due to sampling variability. If the calculated *p*-value is small ($p \leq 0.05$), we can then reject the null hypothesis and conclude that the data are very unusual with the null hypothesis (Motulsky, 2013).

The unpaired *t*-test was also used here to determine whether a significant difference existed between the treatment and control groups. In this study, the calculated *t* values were smaller than critical values in all four variables between the two groups. Therefore, the means were not significantly different. Although the calculated mean differences between the treatment and control groups were positive in all four variables, they were smaller than the initial estimated mean difference (i.e., 0.5): color (0.35); artwork (0.16); amount of daylight (0.16); and quality of window view (0.04). In

addition, 95% confidence intervals (CIs) for the sample mean differences included zero in all four variables (Table 9). This indicated that the 95% CIs contained the value of the null hypothesis, thus, we failed to reject the null hypothesis and concluded there was no statistically significant difference in workplace satisfaction between the treatment group and the control group.

Table 9: Unpaired t-test for the mean difference between treatment groups

Variables	Treatment (N=53)	Control (N=30)	Difference* (95% CI)	*t* score	DF	Critical value	*p*-value
Workspace Satisfaction							
Color	1.51	1.16	0.35 (-0.63, 0.78)	0.871	48	1.677	0.194
Artwork	1.06	0.90	0.16 (-0.97, 0.75)	0.395	55	1.676	0.347
Daylight	0.00	-0.16	0.16 (-1.03, 1.10)	0.299	57	1.676	0.383
Window View	-0.38	-0.42	0.04 (-1.25, 0.94)	0.001	52	1.763	0.500

* The difference is the mean in the "Treatment" group minus the mean in the "Control" group for individuals have no window access. The 95 percent confidence interval (CI) is for the difference in mean between the groups.

From the unpaired *t*-test for individuals with and without window access (in Table 8), it was evident that window access has a significant impact on the workplace satisfaction in this sample. It might be valid to perform an additional hypothesis test to examine the mean difference in workplace satisfaction between the treatment and control groups for those who had no exterior window access. The mean differences in this calculation were much greater than the overall mean difference. The differences for both color and daylight variables exceeded the initial estimated mean difference 0.5. The mean

differences, however, were not statistically significant due to high p-values and 95% CIs contained zero (Table 10).

Table 10: Unpaired t-test focused on individuals have no window access

Variables	Treatment (N=31)	Control (N=16)	Difference* (95% CI)	*t* score	DF	Critical value	*p*-value
Workspace Satisfaction - no window access							
Color	1.19	0.63	0.56 (-1.09, 0.69)	1.173	26	1.706	0.126
Artwork	0.45	0.06	0.39 (-1.22, 1.05)	0.605	26	1.706	0.275
Daylight	-1.45	-2.06	0.61 (-0.81, 0.71)	1.176	36	1.688	0.124
Window View	-1.77	-2.19	0.42 (-1.10, 0.99)	0.760	27	1.703	0.227

***** The difference is the mean in the "Treatment" group minus the mean in the "Control" group for individuals have no window access. The 95 percent confidence interval (CI) is for the difference in mean between the groups.

Open-ended Questions Analysis

Two open-ended questions were included in the survey questionnaire. Question eight asked participants to identify one color they disliked within their workplace environment and to provide a reason for disliking it. Both groups had approximately 60% of participants responding in writing. Among the individuals who responded, nearly half of the participants in the treatment group and more than 60% of participants in the control group responded with either “N/A” or “Love it.” Only one participant in the control group responded that he disliked all colors because he was not “a fan of pastels.”

The summarized list is shown in Table 11. More than 50% of participants in the treatment group and approximately 33% in the control group answered that they had an

issue with at least one color near their workplace. The most complaints were aimed at the green or greenish color in this study (i.e., 21% in the treatment group and 29% in the control group).

Table 11: If you can get rid of one color in your workspace

Treatment (N = 34)	**Reasons**	**Response* no. (%)**
Green/putrid green/ lime green/pea green/ blue green / yellowish green	puke color, weird, hard on eyes, not mood lifting	8 (20.5)
Yellow		4 (10.3)
Beige/white	institutional, increase glare, ugly, boring	4 (10.3)
Orange	unappealing, too strong	2 (5.1)
Brown	too dark	2 (5.1)
N/A, pay no attention		13 (33.3)
Love/Like the color		6 (15.4)

Control (N = 20)	**Reasons**	**Response* no. (%)**
Green/pale green/ mint green/light green/ aqua	institutional, ugly, hate it	6 (28.6)
Yellow		1 (4.8)
N/A, pay no attention		10 (47.6)
Love/Like the color		3 (14.3)
Dislike all colors	not a fan of pastels	1 (4.8)

***** Some participants listed more than one colors resulting in total responses did not match the total sample population (N).

The reasons given for disliking it appeared to be related to the intensity of the color (i.e., how bright or dull a color is), suggesting that the color viewed was hard on the eyes. The general dislike of this color could also be linked to the ambient lighting, which caused the color to have unpleasant associations as demonstrated by the adjectives used to qualify the color in responses, i.e., putrid, puke, ugly, and institutional. It is necessary to point out that participants added not only adjective but also emotional words to describe the color green. The same color appeared to have had multiple interpretations based on individuals' perception. As some of the participants said:

Some specific green colors that remind me puke with bile in it.

Pale green in my office seems very institutional, reminds me of halls in the "Home for the Incurables" I volunteered at in high school.

Question nine asked participants to share any thoughts about their workplace environment. The breakdown list can be found in Table 12. Both groups had more than a 65% response rate. Among the individuals who responded, fewer participants responded positively or had no opinions compared to the color question, i.e., 26% in the treatment group and 9% in the control group.

The issues reported in the present study stretched from location of the workspace (i.e., in the middle of the traffic path thus difficult to perform their work) to housekeeping issues (trash was not emptied frequently enough), from temperature (too cold or too hot) to lack of storage, and from overhead lighting (it appeared that overhead lighting was not consistently distributed) to noise level. These concerns were mostly related to issues influencing workplace satisfaction that were not addressed in the survey questionnaire.

The following comments sum up the majority of the complaints about issues with layout, privacy, and lighting.

> *I do not like that anyone walking by my desk can look at my screen and any contents on my desk. I [am] in a major pass thru hallway that leads to offices and [the] employee kitchen. I constantly have people walking and talking behind me and a very least would like to face out with my computer screen facing wall.*
>
> *The lights are too bright. I suffer from migraines and they are too much. No way to lower the ones above my head.*

Table 12: Anything else you would like to share

Treatment (N = 38)	**Response* no. (%)**	**Control (N = 22)**	**Response* no. (%)**
Layout	8 (16)	Layout	9 (24.3)
Privacy	1 (2)	Privacy	8 (21.6)
Lighting	8 (16)	Lighting	2 (5.4)
Lack of window/daylight	5 (10)	Lack of window/daylight	3 (8.1)
Noisy	3 (6)	Noisy	2 (5.4)
Ergonomic	2 (4)	Ergonomic	2 (5.4)
Lack of storage	3 (6)	Lack of storage	1 (2.7)
Trash/cleaning	2 (4)	Trash/cleaning	2 (5.4)
Temperature	1 (2)	Temperature	2 (5.4)
Dusty	1 (2)	Dusty	1 (2.7)
Equipment	1 (2)	Equipment/furniture	2 (5.4)
Lack of artwork	3 (6)	Lack of artwork	1 (2.7)
Lack of color	1 (2)		
Lack of plants	1 (2)		
N/A	6 (12)	N/A	1 (2.7)
Lovely	4 (8)	Lovely	1 (2.7)

* Some participants listed more than one issues resulting in total responses did not match the total sample population (N)

The lack of daylight and/or window views also received numerous complaints, although most of the participants viewed this issue as more of a psychological factor. A few responses are listed here to illustrate how participants "felt" about this issue.

Would love a window but who wouldn't?

Lack of daylight makes me feel like vampire at work.

Totally dissatisfied with not having a window, coming to work in dark or twilight and returning home in dark gets to be depressing, especially when my work is mainly at my phone and PC.

CHAPTER FIVE: DISCUSSION AND CONCLUSIONS

This chapter discusses the main findings and implications. It also describes the fit with the theoretical and research models, as well as presents recommendations for future research.

Discussion of Findings

The purpose of this exploratory study was to investigate and document the effects of visual design elements as potential factors contributing to health care professionals' workplace satisfaction. Accepting the inevitability of work-related stress (Djukic *et al*., 2010), the present study focused on individuals' perceptions of their workplace satisfaction. Considering how learned knowledge (cognitive expectations) might influence individuals' perception of their workplace environment (Heerwagen & Zagreus, 2005), this study tested for differences in workplace satisfaction between individuals who were given information about the positive effects of the design elements and those who were not. Two open-ended questions were included to allow some explanation of quantitative findings.

Does Visual Design Elements Affect Workplace Satisfaction

The present study reported a higher mean age than the previous studies, i.e., 45 years old versus 30 years old (Alimoglu & Donmez, 2005; Djukic, *et al*., 2010). The study sample also appeared to have longer overall years of work experience than those in

the previous studies, i.e., approximately 80% of participants who responded to the survey had more than 11 years of work experience versus an average of 9 to 10 years (Alimoglu & Donmez, 2005; Djukic, *et al*., 2010). In the literature, demographic characteristics such as age, gender, current job position, and years of work experience were shown to influence individuals' attitudes toward their workplace environment (Manning, 1970; Sadatsafavi *et al*., 2013; Wells, 1970). In this study however, the influence of these factors was less evident. The main reasons for this lack of evidence were because the study population was either insufficiently diverse (majority of the participants were older, were female, and had more than 11 years of work experience) or overly diverse (there were 20 positions reported in the treatment group and 12 positions in the control group). Moreover, no statistical significant relationship was found between workplace configuration and accessibility to window view in this sample population. Therefore, the control variables (i.e., age, gender, years of work experience, and workspace configuration) that were listed in the proposed research model of hypothesized relationships among variables were not relevant to the outcome in the present study (see Figure 3).

Nonetheless, the percentages of the negative responses for individual variables in this study sample seemed high. It is possible that these demographic characteristics (i.e., older population and with longer previous work experience) did play a role in making observations more critical (see Table 7). It could also simply be that the majority of the participants in this facility could not look out a window from their primary workspace

(i.e., 60% in the treatment and 53% in the control groups, respectively). Clearly these suspicions require further research and evidence in order to be proven.

The results from the unpaired t-test showed positive relationships between window access and workplace satisfaction – individuals who had window access appeared to be more satisfied with the choices of color and artwork, not to mention amount of daylight and quality of window view within their workspace. These findings resonated with existing literature that accessibility to nature views and sunlight exposures increased positive workplace attitudes (Almoglu & Donmez, 2005; Kaplan & Kaplan, 1989; Leather *et al*., 1998; Manning, 1970). The findings however were unclear about how much color and artwork compensated for the lack of window access. The data offered some indications (e.g., equal or greater than 60% of participants indicated positive attitudes toward color and artwork while 60% of the participants in the treatment and 53% of participants in the control group had no window access) but not enough data were acquired to confirm these suspicions statistically.

The findings were unclear about how much color and artwork affect workplace satisfaction among health care professionals. It seemed that workplace satisfaction was heavily related to window access in this sample population. For instance, the majority of the participants in the treatment group responded positively to color (81%) in a 7-point rating scale, but more than 50% of those who responded to the open-ended question (34 out of 53) also complained that they had an issue with at least one color near their workplace. The inconsistent responses could be linked to the highly subjective nature of

the factors themselves, thus it is difficult to obtain generalizable evidence as mentioned in the study conducted by Sadatsafavi and Walewski (2013).

The color preference obtained in this sample population nonetheless was both valuable and informative. Existing studies showed that the color blue-green was perceived to be more calming and less distracting than others (Mahnke, 1996; Kwallek *et al*., 2005). In this study, however, one of the greenish colors was among the colors about which there were the most complaints. The many different labels and descriptions (e.g., "putrid green," "lime green," "pea green," "blue green," "pale green," "mint green," etc.) for this disliked color overwhelmingly suggested that there might have been some unities in color reaction. Some participants also expressed emotional or experiential associations in how they described colors, e.g., as the color of puke and bile, the color of an old hallway, etc., signifying that the effects of color may related to learned meaning, as stated by Elliot, *et al*. (2007). Although the perception of color could be a highly personal experience (Holtzschue, 2011), something had triggered a negative reaction in this study site that caused emotional distraction among the health care professionals who work there. A further investigation of this matter may yield additional evidence of color-emotional phenomenon.

Does Being Informed Affect Workplace Satisfaction

The results from the hypothesis testing were not statistically significant (95% CIs contained zero and *p*-values were higher than 0.05) although all four factors showed positive mean differences between the treatment group and the control group. Therefore,

this study obtained no evidence supporting the hypothesis that expectations or being better informed about the benefits of visual design elements influence the workplace satisfaction of healthcare. However, the fact that the treatment group consistently had higher mean scores across all four factors than in the control group tentatively suggests that there may indeed be some correlation between providing information about the environment and the more positive responses provided to survey questions.

It is possible that the difference in sample sizes (i.e., 53 and 30, respectively) resulted in some inconsistency between the treatment and control groups. It is also possible that the "Fact Sheet" presented in the treatment group did demonstrate certain influence on participants' psychological states. The lack of statistical significance might have resulted from insufficient information in the fact sheet or simply due to there not being enough time for participants to absorb the information before answering the survey questions. An educational seminar or allowing health care professionals to participate in the design process might provide a better "treatment" in this case and result in a statistically significant difference in this matter.

Revised Research Model of Relationships Among Variables

The research model of hypothesized relationships among variables is revised based on the statistical analysis (see Figure 9). The initial hypotheses were only partially supported, namely, the presence of the identified visual design element (e.g., window view) contributes to the workplace satisfaction of health care professionals.

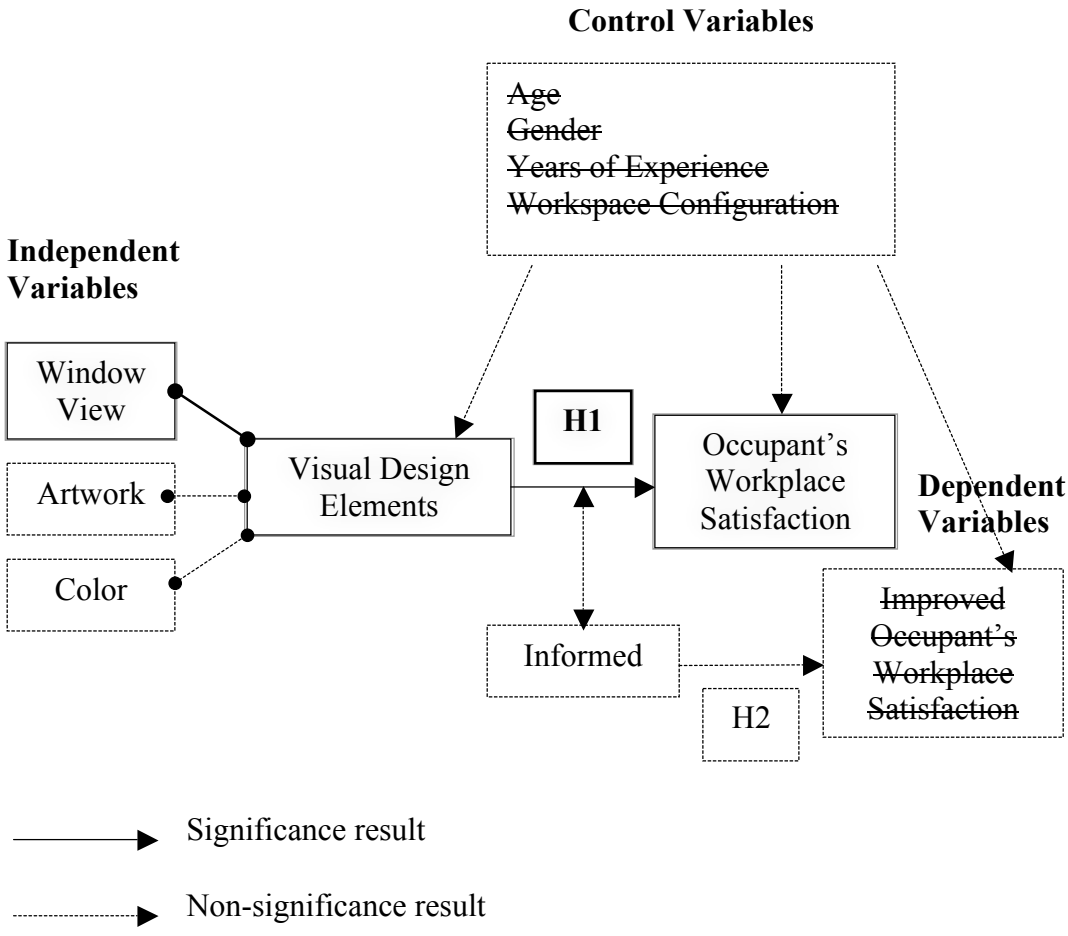


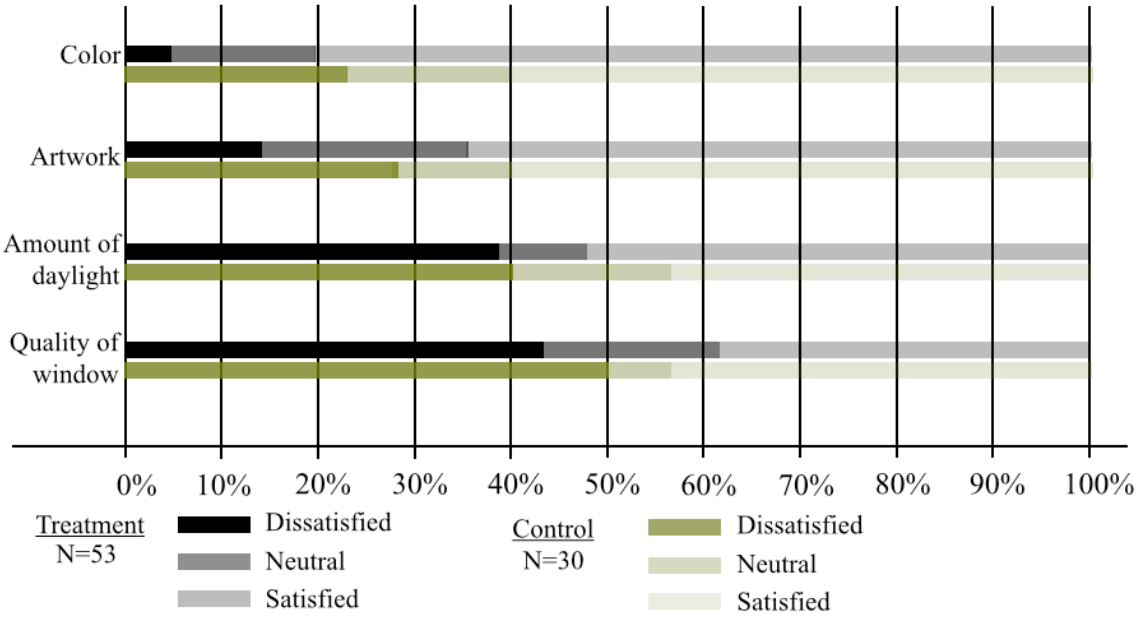
Figure 9: Revised research model of hypothesized relationships among variables

Interpretation of Non-Significant Results

The 95% CI convincingly demonstrated that the difference between treatment and control groups was unlikely to be statistically significant because the data were consistent with the null hypothesis. Therefore, a conclusion could be drawn that either learned knowledge (cognitive expectations) in individuals had no effect in the present study or that the difference was so small that it could not be detected. However, the treatment group did score consistently higher satisfaction means than the control group among all four proposed variables. This suggests the possibility that being better informed about the benefits of the health care workplace environment might increase employees' workplace satisfaction.

A chart depicting the percentage of responses indicating dissatisfaction or satisfaction towards each of the independent factors is shown in Table 13. It showed that the participants in the control group responded with higher percentages of dissatisfaction, and lower percentage of satisfaction than in the treatment group in all variables but the quality of window views. The result was more significant than it might first seem because higher percentages of participants in the control group had visual access to windows than in the treatment group (47% and 40%, respectively). In addition, since the demographic characteristics in this sample population were not identified as being as important as in the studies conducted by Holtzschue (2011) and Sadatsafavi *et al.* (2013), the results are more meaningful than they seem.

Table 13: Satisfaction percentages among individual variable



Implications

In the present study, window access appeared to be significantly related to workplace satisfaction. Although it may be unfeasible to incorporate windows in all workplaces due to the physical functioning of the facility, alternative innovative solutions might provide a way by which to obtain a similarly positive effect. A passive approach may simply involve incorporating new technologies to compensate to some degree for environmental shortcomings. One example of such a technology is an artificial skylight system recently developed by a group of Italian scientists, CoeLux. This lighting system mimics the "feel" of the daylight (Jobson, 2015). The technology involves filtering a light

source through a diffuser made of "nanoparticles that mimic Earth's atmosphere." The light produced by this fixture thus resembles the color as well as the actual diffuse quality of sunlight (see Figure 10).

Figure 10: Artificial skylight system

An active approach may involve changing the ways of traditional design practice. If occupants' learned knowledge (cognitive expectations) could in fact influence their experiences about their immediate environment, a research-based practice (i.e., evidence-based design and/or informed design) that makes use of the best evidence in making design decisions could be both constructive and beneficial (Stichler & Hamilton, 2008). As mentioned in the theoretical framework section, cyclical feedback from occupants was

critical in monitoring and producing meaningful outcomes (Stokols, 1987). Periodical pre- and post-occupancy evaluations to existing facilities are ideal methods for collecting a vast corpus of information about working conditions that might be used for future projects (Preiser, 2001).

With regards to the implementation of colors and artwork, it appears to be more complicated than originally expected. For instance, the name of the color does not always convey the actual hue that is perceived by individual due to various light sources, either artificial or natural. Different surfaces seem to have an effect on the color as well. For these reasons, it seems risky for design professionals to formulate universal guidelines or make sweeping generalizations about the performance of any specific color. As stated in Tofle, *et al.*'s study (2004), the meaning of color should not be solely based on color theory; social and cultural backgrounds of individuals should also be taken into account as well in determining what colors might mean. Tofle, *et al.* suggested that to make sense of the colors used in a healthcare environment, designers needed to study the local context of each healthcare setting, in other words, to understand and identify the specific user groups within their local backgrounds.

In a recent report in the health care industry, existing technologies such as Virtual Reality (VR) to help users to "experience" the facility before it was built (Cupp, 2015) have been reinvented and used in design practice. This is a step-up from the traditional facility prototyping (e.g., full-scale mock-ups) mainly to provide simulating reality for users and to support decision-making process. This method may be used to explore

potential preference for more subjective design factors such as color and artwork in the target population.

Implications for Future Research

Future studies will benefit greatly from a revised study instrument (i.e., POE questionnaire) based on lessons learned of this thesis study. To begin with, to more accurately assess how prior work experience affects workplace satisfaction, question #3 under Background "What are your total years of work experience?" might be improved by splitting it into two questions: 3a "How many years have you worked for this company" (revised from CBE) and 3b "How long have you been working at your present workspace" (CBE/SPOSE). Splitting this question into two separate questions could help clarify whether the subjects' work experiences were within the same company, and how long they had been working in the current workspace. Consideration should be given to the possibility of removing question #4 "What is your position" from the questionnaire because the subject matter is too broad to generate a meaningful discussion.

Next, to keep a study more precise and to make it easier for participants to answer all of the questions within the allotted time, five items (i.e., workplace furnishings, amount of overhead lighting, quality of overhead lighting, sound privacy, and overall cleanliness and maintenance) under the general question "How satisfied are you with the following design aspects in your workspace" should be replaced by items directly linked to research questions. Items added should focus on the relationship

between the "perceived" visual comfort of the independent variables and the dependent variables, e.g., colored walls under artificial lighting/natural light, intensity of the color, content of the artwork, and size and color of the artwork. A question regarding overall satisfaction might also be added in this section to explore the relationship between subjects' conscious or subconscious expectations regarding what effect the visual design elements should have on them and their actual workspace satisfaction.

Finally, to test for the fit with the theoretical and research models (see Figure 2 and Figure 3), that "what one sees" influences "how one feels," it may be beneficial to include questions such as "Does the color (artwork/window view) of your workspace enhance or interfere with your ability to get your job done" (revised from CBE). Questions like these allow for cross-examination between the independent variables (i.e., window view, artwork, and color) and the dependent variable (i.e., occupants' workplace satisfaction),

The proposed revised POE questionnaire is shown in Appendix C. It would be important to conduct a pilot study to test the internal validity of the survey instrument with the intended target population before actual study.

Future Research

The results of this study suggest the potential benefit of an approach utilizing an experimental feature. The value of an experimental feature in studying the designed environment has been demonstrated already in other studied topics. The study conducted

by Ulrich (1984) for example, used an experimental feature to explore linkages between the designed environment and patients' health outcomes. Langer's (2009) study similarly used an experimental design to explore the impact of the designed environment on the psychological and physiological well-being of users in those spaces. A better-structured study design guided by environmental therapeutic theory could similarly yield tangible and empirical evidence clearly demonstrating potential environmental factors affecting health care professionals' well-being and activities.

A more comprehensive study, one using a combination of quantitative and qualitative research methods that identifies health care professionals' perceptions of which specific physical environment features have a great statistical influence on their workplace satisfaction would be beneficial. The results obtained from such a study could be used to develop more comprehensive measures for setting up the design goals and objectives of the designed environment. Understanding the differential effects of features of the physical environment would also be useful for directing how resources should be invested in different features of the physical environment in order to ensure the greatest benefit to health care professionals in terms of making their workplaces aesthetically and functionally appealing.

It may also be worthwhile to consider investigating the negative impact of the designed environment in relation to health care professionals workplace satisfaction. People seem to be able to easily identify something they are not happy about or to detect what is bothering them in their work environment. The results of identifying those things

that are causing them distress may provide us with new insights into workplace issues, or present new factors that were not initially anticipated.

In seeking to identify factors negatively affecting workplace satisfaction, it might be useful to consider looking for correlations between visual design elements and sick leave or turnover rates among health care professionals. Although it is difficult to quantify and measure individuals workplace satisfaction based on cross-sectional observation, especially in an environment as complicated as a health care environment, sick leave and/or turnover rates possibly could provide a more objective measure for identifying negative factors than just self-reported satisfaction. Such an approach however would likely require the use of advanced statistical techniques with multiple predictors that could simultaneously correct or adjust for other relevant variables.

Conclusion

Happier health care workers provide better care for their patients and healthier workplaces make it easier for health care workers to be happier. Although the impact of design elements such as color and artwork may seem trivial and inconsequential in terms of the overall design schema, their cumulative impact on occupants could be significant. It would be beneficial to not overlook any individual design factor in seeking to create a more comprehensive built environment. The positive correlation obtained between the visual design elements and workplace satisfaction from this study suggests that a pleasant workplace may indeed positively influence health care workers' health and happiness,

that is, that there indeed might be a connection between “looking good” and “feeling better.” In spite of the fact that this study does not address the last part of the title, namely “doing great,” existing research does suggest that this connection is also likely.

In addition to the above, it is hoped that this study demonstrates how through understanding the ways in which individuals respond to their physical environment, it may be possible to more easily establish communal criteria for built environments that support occupants’ well-being and activities. Health care institutions in particular could benefit in this regard, able to make the most efficient use of limited resources to provide the best health care possible.

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APPENDIX A: THE FACT SHEET

POE – Group A

Facts about the designed environment for you to know before taking the survey

Research has demonstrated that human beings primarily process information and store memories through vision. It has shown that the incorporation of certain visual design elements such as exterior window views, artwork, and accent color can benefit workers both psychologically (improved emotional state, greater sense of well-being and job satisfaction) and physiologically (reduced signs of physical stress, improvements in posture and blood pressure) by eliciting recall of positive memories associated with these visual design elements.

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APPENDIX B: CONSENT FORM AND SURVEY QUESTIONNAIRE

POE – Group A and B

Consent Form

Study Number: 1403E49162

Consent Form for Occupancy Evaluation of Workspace
You are invited to participate in a research study because you have a workspace in the newly finished Medical Office Building. We ask that you read this form and ask any questions you may have before agreeing to be in the study. This study is being conducted by Autumn Lin, as part of the requirements for completing her master's degree in Interior Design – Evidence-based design, at the University of Minnesota.

Background Information
The purpose of this study is to better understand healthcare professionals' perceptions of their workplace environment. The survey will take less than 10 minutes to complete. The survey results will be incorporated into ongoing research conducted at the University of Minnesota regarding how design can influence or improve workplace satisfaction in healthcare facilities.

Procedures
If you agree to be in this study, please complete the on-line questionnaire. Your employer will receive a report of the overall analysis.

Risks and Benefits of Being in the Study
There are no risks or benefits to you for being in this study.

Confidentiality
The records of this study will be kept private. In any report we might publish, we will not include any information that will make it possible to identify an individual. Research records will be stored securely, and only researchers will have access to the records. Your employer will not have access to these records.

Voluntary Nature of the Study
Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota. You are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions
If you have any questions or concerns regarding this study, please contact the researcher, Autumn Lin, at sautumnlin@gmail.com. If you would like to communicate with someone other than the researcher, you are encouraged to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware Street SE, Minneapolis, MN 55455, or (612) 625-1650. © 2014 Regents of the University of Minnesota. All rights reserved.

Directions: There are several pages in this questionnaire, and completion of the entire questionnaire is important to understand how your building meets your needs.

1. Answer YES to provide your consent and complete the questionnaire.

   ○ Yes

   ○ No

Next

POE - Group

Background

2. Demographic information:

What is your gender?

What is your age?

3. What are your total years of work experience?

- Less than 1 year
- 1-5 years
- 6-10 years
- More than 11 years

4. What is your position?

- Physician
- Medical assistant
- Nurse practitioner
- Other:

Prev Next

POE - Group

Workplace environment

5. Personal workspace description:

- ○ Enclosed office, private
- ○ Enclosed office, shared with others
- ○ Workspace with low partitions
- ○ Workspace with no partitions (just desk)

6. Can you look out a window from your primary workspace? (* If you answer "YES", you may skip question #7)

- ○ Yes
- ○ No

7. In the absence of an outdoor window view, how do you feel about the following substitutions?

	Very dissatisfied -3	-2	-1	0	1	2	Very satisfied 3
Artwork	○	○	○	○	○	○	○
Accent color on the wall	○	○	○	○	○	○	○
Interior windows	○	○	○	○	○	○	○

8. How satisfied are you with the following design aspects in your workspace?

	Very dissatisfied -3	-2	-1	0	1	2	Very satisfied 3
Your workspace furnishings (e.g., chair, desk, etc.)	○	○	○	○	○	○	○
The use of the colors on walls (e.g., choice of colors, location of the colors on walls, etc.)	○	○	○	○	○	○	○
Artwork (e.g., size, placement, subject, etc.)	○	○	○	○	○	○	○
The amount of overhead lighting in your workspace	○	○	○	○	○	○	○
The quality of the overhead lighting (degree of problem with glare, reflectio etc.)	○	○	○	○	○	○	○
The sound privacy in your workspace (ability to have conversations without your neighbors overhearing and vice versa)	○	○	○	○	○	○	○
The amount of daylight exposure in your workspace	○	○	○	○	○	○	○
The quality of exterior window views in your workspace	○	○	○	○	○	○	○
The overall cleanliness and maintenance of your workspace	○	○	○	○	○	○	○

9. If you could get rid of one color in your workplace, what would it be? Why?

10. Is there anything else you would like to share about your workplace environment?

Thank you for your time and thoughtful responses!

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APPENDIX C: REVISED SURVEY QUESTIONNAIRE

1. Answer YES to provide your consent and complete the questionnaire.

   ○ Yes

   ○ No

   Next

POE - Group

Background

2. Demographic information:

What is your gender?

What is your age?

3. How many years have you worked for this company?

- Less than 1 year
- 1-5 years
- 6-10 years
- More than 11 years

4. How long have you been working at your present workspace?

- Less than 6 month
- 6-12 months
- More than 1 year

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POE - Group

Workplace environment

5. Personal workspace description:

- ○ Enclosed office, private
- ○ Enclosed office, shared with others
- ○ Workspace with low partitions
- ○ Workspace with no partitions (just desk)

6. Can you look out a window from your primary workspace?

- ○ Yes
- ○ No

7. In the absence of an outdoor window view, how do you feel about the following substitutions?

	Very dissatisfied -3	-2	-1	0	1	2	Very satisfied 3
Artwork	○	○	○	○	○	○	○
Accent color on the wall	○	○	○	○	○	○	○
Interior windows	○	○	○	○	○	○	○

8. How satisfied are you with the following design aspects in your workspace?

	Very dissatisfied -3	-2	-1	0	1	2	Very satisfied 3
The color selections on walls	○	○	○	○	○	○	○
The visual comfort of the colored walls under natural light	○	○	○	○	○	○	○
The visual comfort of the colored walls under artificial lighting	○	○	○	○	○	○	○
The intensity of the color selections on walls	○	○	○	○	○	○	○
The content of the artwork selection	○	○	○	○	○	○	○
The size and color of the artwork selection	○	○	○	○	○	○	○
The amount of daylight exposure	○	○	○	○	○	○	○
The quality of exterior window views	○	○	○	○	○	○	○
The overall visual comfort of your primary workspace	○	○	○	○	○	○	○

9. Do the following design aspects in your workspace enhance or interfere with your ability to get your job done?

	Interferes -3	-2	-1	0	1	2	Enhances 3
Artwork	○	○	○	○	○	○	○
Accent color on the wall	○	○	○	○	○	○	○
Window view	○	○	○	○	○	○	○
Daylight exposure	○	○	○	○	○	○	○

10. If you could get rid of one color in your workplace, what would it be? Why?

11. Is there anything else you would like to share about your workplace environment?

Thank you for your time and thoughtful responses!

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