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Light Image Therapy in the Health Care Environment.

Anna Rae Dutro
East Tennessee State University

Light Image Therapy in the Health Care Environment

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by

Anna Rae Dutro

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W. Andrew Clark, Ph.D., Chair

Andrew J. Czuchry, Ph.D.

Nancy Nehring, Ph.D.

ABSTRACT

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Use of positive distraction in the built healthcare environment to assist in alleviating stress in a patient was investigated. A backlit light image was mounted in the ceiling of an examination room to create a positive distraction for patients in the ETSU Pediatric Clinic in Johnson City, TN. Survey instruments were used to collect sample data from patients and physicians in a randomized, balanced controlled study designed to determine if patients experienced less stress in the room with the backlit image as compared to other rooms (treatments). Although a statistical difference was not determined between the room with the backlit image and positive and negative control rooms, patients in rooms containing nature art tended to exhibit less anxiety. Researched based knowledge for creating positive distractions in the built healthcare environment helps designers create environments that benefit the patients, their families and medical staff of healthcare facilities.

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CHAPTER 1

INTRODUCTION

The built healthcare environment presents many different and frightening elements to patients, their family, and their friends. As healthcare focuses on maintaining biological homostasis, the physical environment becomes sterile and lifeless. Healthcare staff, patients, and visitors experience stress from both the medical procedures and poorly designed medical facilities. The intent of this investigation is to research the possibility of improving the healthcare built environment to reduce stress in patients. This study focuses on creating a positive distraction in the facility to assist in reducing stress and anxiety in the patient, the patient's family, and the patient's friends, and consequently in the medical staff including attending physicians. The positive distraction selected for this study is a nature art light image unit installed in the ceiling of an examination room directly overhead the patient's exam table. The null hypothesis states that a nature art light image installed in the ceiling of a patient's examination room will have no effect on the level of stress and anxiety in the patient undergoing medical care.

At this time designers rely only on their experience or instinct to create healthcare environments, and many designers do not know the importance of designing healing environments. Little is known of the effect that the built healthcare environment has on the patient's medical outcome, so designers have little direction based on sound research to use in creating healing environments. With the costs of constructing healthcare facilities and the costs of medical treatment rising each year, designers need to make every dollar spent on healthcare environments cost effective. Without research based data, the designer has no guidelines to direct the development of the design. Supplying designers with researched based knowledge on creating healing healthcare environments benefits the patients, medical staff, including physicians, as well as the owners and managers of healthcare facilities.

CHAPTER 2

LITERATURE REVIEW

Many architects and interior designers design hospital facilities with a near total ignorance of the role the built environment plays in the outcome of the health of the patient. At this time, designers create spaces using their only available tools; their intuition, personal preferences, and the current fashion of style. Inflation, natural disasters, China's desire for steel and rising costs of copper and oil increase the costs of healthcare construction each year. The cost of building a hospital has risen as much as 10% per year since 2004 driving construction costs to $265 and $275 per square foot (“Hospital Construction,” 2006.) With the rising costs of healthcare construction, designers need to focus on making every design decision benefit the patient and the success of the healthcare facility. Designers need researched based knowledge to ensure the healthcare facilities built or remodeled today satisfy the needs of the key stakeholders.

Architects and interior designers have little relevant research to guide their design decisions. Designers need answers for the healthcare environmental design questions. The emphasis in design was placed on functionality and maintaining biological homostasis. “Little emphasis has been given to creating surroundings that calm patients and help them cope with the anxiety that is part of the healthcare experience. This tunnel vision produced stressful, institutional healthcare environments working against the promotion of health” (Ulrich, 2001, p. 42.). When patients reacted negatively to the institutional environment, healthcare facility owners and managers, designers, and healthcare personnel began to rethink the design of the built healthcare environment. Acknowledging that a problem existed with the built healthcare environment was the first step in the equation. The next step entailed how to rethink the design process to create a healing healthcare environment.

Seeing the need for modern scientific research to fill this knowledge gap, The Center for Health Care Design (the Center) began in 1988 to document and promote evidence based design. In 1998, The Center published a status report "An Investigation to Determine Whether the Built Environment Affects Patients' Medical Outcomes." This report, researched and written by the Quality of Care Research team of Johns Hopkins University, stated, "This analysis suggests that a cause-effect relationship exists between some healthcare environmental factors and therapeutic outcomes for some types of patients" (Rubin, Owens, & Golden, 1998, p.ix). The research team selected 1,219 articles from a data base of 78,761 that seemed to "describe investigations into the impact of environmental elements on healthcare outcomes" (Rubin et al., p.viii). Out of the 1,219 articles the team selected only those 84 articles that used correct methodological rigor to use in the report. The conclusions drawn from this report state:

1. The large majority of published studies using correct research designs found that an environmental feature is related to health outcome in the short term.

2. Studies on the effect of the environment on health outcomes are rare. Many characteristics of the healthcare environment and patient populations have not been investigated.

3. Many published studies have substantial methodological defects. Future research into the effects of the environment on the patient's health outcome should be carefully composed and carried through with excellent methodological rigor (Rubin et al., p.3).

Other sources echo the lament. Varni, Burwinkle, and Kurtin (2001, p. 135) state that though healthcare providers and healthcare designers have come to "believe that the hospital environment can affect the mood, stress level and perceived overall health of patients and families"; studies to gather empirical data are few and inconclusive. The development of measurement instruments to evaluate the key stakeholders' evaluation of the built environment with valid methods is missing from the literature. Wells-Thorpe, well-known British architect, states studies must be made to shift the argument from the fashion and aesthetics into a discipline with valid measurable results confirming the effect the built environment has on a patient's outcome. Only then will the subject be taken seriously and the findings used (Wells-Thorpe, 2001).

The John Hopkins Research Team recommended four research methods to use as a guide for the development of future research protocols maintaining methodological rigor.

1. "Randomized, controlled studies – listed as the best method
2. Experimental trial with paired data
3. Observational study with paired data
4. Observational study of different groups" (Rubin et al., 1998, pp. 4-5)

The Effect of Stress on Healing

Over the last 15 to 20 years academic research began to focus on the relationship between stress and healing (Stouffer, 2001). Stress, a mobilizing force that helps a person deal with a threatening situation, is a beneficial physiological reaction. Yet, when a person stays in the stress mode, the body works overtime producing cortisol, a hormone that increases blood pressure and blood sugar levels and suppresses the immune system. When the immune system is suppressed, wounds tend to heal more slowly and the recovery process is slowed. Studies proved prolonged stress increases higher heart rate and muscle tension and produces anxiety, depression, and a sense of helplessness. Research studies also suggest lowering stress can reduce patient anxiety, lower blood pressure, lessen pain, and in some situations shorten the stay in the healthcare facility (Ulrich, 2001; Ulrich, Zimring, Quan, Joseph, 2006; Wells-Thorpe, J., 2001).

If the built environment can be constructed with elements that reduce stress in the patient; the patient, the patent's family, healthcare staff, and facility owners will benefit. The researchers' job is to identify factors in healthcare facilities that produce stress and what factors help to reduce stress. After identifying these factors, designers will have research based knowledge to guide them in the creation of a healing healthcare environment.

Ulrich, a leader in research design on the effects of the built environment on the health outcome of the patient, gives a general guideline to create a supportive environment to eliminate stress in the patient or help the patient and patient's family cope with the stress. He lists three important factors to help the patient cope with stress.

1. "The patient needs a sense of control over the built environment.
2. The patient needs social support from family and friends.
3. The patient needs access to nature and other positive distraction" (Ulrich, 1997, p.44).

People have a strong desire to control their surrounding physical environment. When a person views the environment as uncontrollable, stress occurs. In the healthcare situation, the patient has no control over pain, diet, scheduling of events, health caretakers, or length of stay in the hospital. The patients' sense of control is drastically reduced when they are "forced to look directly at glaring ceiling lights while bedridden with no ability to adjust room lighting and temperature" (Ulrich, 1997, p. 44). A lack of control over privacy also contributes to a patient's stress. Studies showed stress produced by a lack of control can produce "depression, helplessness, cognitive performance, elevated blood pressure, higher levels of circulating stress hormones and suppression of immune functioning" (Ulrich, 1991, p.100). Patients who sense control over their environment are better equipped to cope with stress that results from a medical treatment. This in turn produces less anxiety and ensures a better health outcome (Ulrich, 2001).

In my opinion, designers can give the patient and supportive family more control by providing excellent wayfinding directions through signage and architectural features. Other areas to ensure the patients' need to be in charge include lighting and temperature control in the patient's room, access to areas in the patient's room to display personnel objects, and control over their privacy.

Social support from family and friends improves the health outcome of patients. Stouffer (2001) reports that research has shown in health and non healthcare situations people with a high level of social support (as compared to people with lower support) experience less stress and show higher levels of wellness. Healthcare facilities embraced this idea and now provide support programs for patients and families. Little research has been conducted on social support in the physical environment. Yet, it stands to reason, in my opinion, that giving social support in the built environment encourages family and friends' support of the patient.

An environment that welcomes visitors can be created by providing space and furnishings in the patient's room for a family member or friend to stay overnight (Stouffer, 2001). Waiting areas can be made available with moveable furniture where family and friends can gather. Kitchenettes would allow families to prepare food for patients they are visiting. Gardens and nature areas can provide a beautiful setting for social interaction with the patient. Care must be taken in the design of social supportive areas to provide areas of privacy. An environment that denies privacy can be viewed as very stressful by the patient (Ulrich et al., 2006).

Patients need nature and positive distractions to lower stress. Ulrich identified a positive distraction in the built environment as “an element that increases levels of positive feelings, effectively holds attention or interest, may block or reduce worrisome thoughts and produces desirable physiological changes such as reduced blood pressure” (Ulrich, 1997, p.45). Positive distractions are elements in the environment that eliminate stress or strengthen the patient and visitor abilities to cope with the stress. Positive distractions in the visual environment are found in nature (trees, plants, water, and light), caring or smiling faces and art work. Research shows access to nature, daylight, art, and music can result in a patient using fewer drugs and spending less time in the hospital (Dilani, 2001). To enforce this theory, studies made on the absence of positive distractions or low levels of exposure to positive distractions show high levels of anxiety and stress in the patient. Research in intensive care units revealed lack of windows, unvarying lighting, and the constant sounds of equipment were associated with stress, depression, delirium, and even psychosis (Ulrich, 1997).

Florence Nightingale was an advocate for the need of a patient’s exposure to nature and sunlight to facilitate the healing process. She stated light is essential to both health and recovery. Nightingale wrote that the first importance to the patient is a view of nature and sunlight. Florence Nightingale observed that almost all patients lie with their faces oriented to the light as a plant keeps its head in the sun. “Without sunlight we degenerate in body and mind” (Nightingale, 1860, p. 123).

Yet, modern designers did not heed the advice of Florence Nightingale. As the medical profession became more knowledgeable in providing healthcare, the environment focused on the physiological treatment of the patient ignoring the emotional and psychological needs of the patient and family. The healthcare environment became cold and sterile as it aimed toward physical healing. Designers did not understand the patient's total well being; the physical, intellectual, emotional, and social needs of the patient. The physical implications of stress on the patient from the built environment were unknown. When support of the needs of the patient was removed, problems mounted. Even though there is little rigorous research available on the effects of the built environment on the health outcome of the patient, the research that is available indicates positive links between environmental characteristics and patient health outcomes (Ulrich, 2001).

Nature in the Built Environment

Nature or simulated nature scenes are a positive environmental feature that does facilitate stress recovery. Results of studies suggest that views of everyday nature or pictures of nature help the psychological and physiological recovery from stress. It is suggested that nature scenes create positive thoughts and reduce negative emotions such as fear, anger, and unhappiness. The positive thoughts block or reduce stressful thoughts. It has been shown that scenes of nature generate recovery faster than scenes of urban buildings. Researchers measured the blood pressure, skin conductance, and muscle tension of subjects who had driven through stressful traffic or had just taken a problem solving test. The subjects exposed to nature recovered faster and more completely than the subjects looking at a built environment (Ulrich, 1997).

This research was taken into the healthcare environment in a dental office. Patients were placed in a waiting room with a large nature scene mural on the wall and waited for at least 10 minutes before seeing the dentist. The patients were surveyed by questionnaires. The results suggested the patients felt less stress on the days when the mural hung on the wall than the patients on the days when the wall was left blank. Heart rate measurements were also taken and indicated that the patients were less stressed on the days when the mural was hung on the wall. In another test people waiting to donate blood were exposed to a wall-mounted television with videotapes of nature one day and regular television shows on another day. The test group watching the nature videos had lower blood pressure and pulse rates (Ulrich et al., 2006).

Healthcare givers are recognizing positive distractions as beneficial to the patient. Positive distractions are being used in treatments for lowering the need for pain medication. Several good studies have shown that views of nature lower a patient's stress and pain (Dilani, 2001; Wells-Thorpe, 2001). The theory of why this works is called the distraction-pain theory which states that people have a limited amount of available conscious attention. Pain requires a patient's constant attention, so when the available attention is used for something else, there is less attention to give to pain resulting in the patient experiencing less pain. The gate-control theory of pain explains the distraction-pain theory in another way. The gate theory states, "the transmission of nerve impulses through the spinal cord to the brain is modulated by spinal mechanisms that act like a gate. Environmental distraction can close the gate and prevent or reduce the transmission of pain nerve impulses, so inhibiting pain messages from reaching the brain" (Ulrich et al., 2006, p. 47).

Studies continue to show the affirmative aspects of using nature as a positive distraction. Patients recovering from gall bladder surgery needed less pain medication and showed better emotional well-being when recovering in a room with a window with a view of nature versus patients recovering in a room with a window looking into a brick wall (Ulrich, 1991). Viewing a video tape of nature lowered the pain and anxiety of burn victims as their dressings were changed (Wells-Thorpe, 2001). Patients undergoing a painful bronchoscopy procedure experienced less pain when looking at a nature scene installed in the ceiling as compared to patients viewing a blank ceiling during the procedure. In a well-controlled study patients showed a higher threshold for pain when looking at a videotape of nature compared to patients viewing a blank screen (Diette, Lechtzin, Haponik, Devrotes, & Rubin, 2003).

One interesting study was conducted proving positive distractions are a powerful key to eliminating stress and lowering pain. David Patterson, professor of Psychology and Surgery at the University of Washington Medical School in Seattle, demonstrated how burn victims obtained relief from pain by viewing a virtual reality landscape full of soothing ice and snow. This program titled “SnowWorld” revolutionized pain treatment.

> SnowWorld is so powerful that viewing and interacting within it can lower a person’s pain perception by half. Victims with severe burns often suffer from excruciating pain during rehabilitation, but the program immerses the patient in a virtual environment filled with snow, penguins, snowmen, igloos and woolly mammoths. Pain requires conscious attention, so by taking the user’s attention away from the pain, there is less attention available for the person to process the pain signals (“Alienware ensures”, 2007. p 2).

The program developed in 2003 was chosen by the Smithsonian’s Cooper-Hewitt, National Design Museum for its National Design Triennial as part of 2007 Design Life Now Exhibit. Physicians foresee the virtual reality treatment replacing part of the use of debilitating and expensive drugs (Wells-Thorpe, 2001).

In my opinion, one unknown in the area of using positive distractions to lower the need for pain medication is the length of time the distraction works on the patient. This area requires further research to determine the effectiveness of the treatment.

Positive distractions can come from nature, art, music, and the built environment. Research has shown using these positive distractions can result in a patient using fewer drugs and spending less time in the hospital (Cintra, 2001, Ulrich, 2001). In my opinion, the designer can use this knowledge to incorporate into the designed environment positive distractions that benefit the health outcome of the patient.

Art in the Built Environment

Arts improve the quality of the built environment. Art gives a caring look to the space and gives the space an identity. Care must be taken by the designer to choose art that edifies the patients' well–being. A designer must not specify art to satisfy the designers' tastes and desires. The art must be selected to edify the patient (Cintra, 2001).

In 8 hospitals over 4500 people took part in interviews and surveys to determine people's art preferences. The results stated that hospital ambience should reflect nature, the local community, and the diversity of different services. A survey taken in a Liverpool hospital showed the staff in particular thought good art made people feel better (Cintra, 2001).

Good art in healthcare pulls a person's attention to the art creating a positive distraction. The art needs to show empathy for the patients, visitors, and staff by providing a caring appearance. When figures of people are contained in the art, the people must have pleasant or smiling facial expressions with the ambience of peace and rest. The art should create a feeling of well being and support social interaction (Ulrich, 1997).

Art styles and subjects vary extensively. Art can be beautiful, uplifting, calming, ambiguous, emotionally challenging, offensive, or disrespectful to the patient. A study revealed that abstract, ambiguous (surreal) or emotionally charged art exacerbates stress in a patient and worsens the patient's outcome. Heart surgery patients given a picture showing a lake and trees experienced less stress than a control group of patients with no picture. In the same study, patients given a picture of abstract art revealed more stress than the control group with no picture (Ulrich et al., 2006). Carpman and Grant (1993) gathered inpatients' art preferences from a wide range of backgrounds and found the inpatients wanted art representing nature. In the same study the inpatients expressed a strong dislike for abstract art. Another study listed by Carpman and Grant (1993) asked a group of African Americans and Caucasians to choose art they considered suitable for patient rooms. Their choices contained nature scenes, rural landscapes, and paintings of people with pleasant faces and caring gestures surrounded by nature scenes such as a garden.

To further support the case against using abstract art in the healthcare environment, a preliminary study was documented of the effects of wall art in a psychiatric ward for short-term patients at a Swedish Hospital. In interviews with the patients, positive attitudes were expressed for the paintings dominated by nature. Many negative comments were made about the abstract art paintings containing unclear and undefined subject matter. Some patients stated the abstract art upset them, and other patients asked that the art in their room be taken away because it disturbed them. In past years in the same ward a patient described as non-violent tore a picture from the wall and smashed the frame. Seven paintings and prints were identified by the staff as the target of a non-violent patient's physical attack. Five of these paintings had been attacked more than once and so removed. None of the seven paintings and prints contained nature representations. All displayed ambiguous content with disorder and chaotic colors (Ulrich, 2001).

Ulrich stated a person who is ill will interpret art differently than a well person (Malkin, 2006). A picture with an empty chair may suggest a beckoning to relax to someone not under emotional stress while the same picture predicts a coming death to a patient with cancer or to the patient's spouse. Defined as the emotional congruence theory, it states a person will bias his or her perception of the environment to match his or her state of mind. Pictures of nature work best in relieving stress in the patient remaining more neutral and promoting more relaxation. Malkin further (2006) stated that compositions of nature with an element of mystery such as a path leading into the woods compelling the viewer into the picture work best to calm the patient.

Studies show that all art with nature is not equal in promoting a patient's well-being. Shepley, Fournier, and McDougal (1998) reported that Coss studied the effects of different types of pictures on highly stressed patients in a pre-surgical waiting room. Patients viewing serene and calm nature scenes had lower blood pressure than patients viewing stimulating nature scenes (e.g., "a sail-boarder leaning into the wind, a view of nearby zebras facing the observer") or the control group viewing no pictures (Ulrich, 1997, p. 47). Coss concluded the stimulating pictures were inappropriate for highly stressed patients.

Color in the Healthcare Environment

Other key elements of the built environment; color, lighting, and finishes can be used to create positive distractions. No rigorous methods of research have been conducted on the effect of color in the healthcare environment or other environments. What knowledge we have about color comes from grounded theory obtained from qualitative research. (Grounded theory obtains information from multiple stages of data collection that the researcher refines to find the similarities and differences of information in the groups being tested. No theory is projected at the beginning of the research. The theory is projected from the information obtained through the study) (Creswell, 2003).

Color in the healthcare environment during the turn of the 20th century created a dull monotonous environment of white. Thought to be a clean and germ free color, white dominated the walls, ceilings, woodwork, linens, and furniture. Birren (1979) reported current studies indicate a continuous exposure to environments with little or no stimulation result in a disorientation of brain functioning. Birren stated a number of volunteers submitted to confinement in a bland environment for a period of 36 hours all reported difficulty in concentration, difficulty in judging the passage of time, and periodic anxiety feelings. Eight of the volunteers reported some distortions of reality. In another study, Vernon, (1966) reported infants under 7 months old kept in a hospital nursery with no color and visual stimuli over a period of 1 to 2 weeks continued to stare with blank looks on their faces after being taken home.

As the nation prospered in the 1920s natural wood furnishings with colorful fabric became popular in some areas of the hospital. During the 1930s, the first strictly functional color, hospital green, was used. The need for this color in the operating room developed as the operating rooms moved from top floors with skylights and artificial lighting to interior rooms with only artificial lighting. The combination of white walls, white sheets, white hospital scrubs, and artificial lighting created glare. When physicians or nurses looked away from the open cut during the operation, they were blinded by the glare. Birren (1979) reported that in this same 1930s time period, Flagg recommended painting the walls of the operating room with a blue-green, the complimentary color of the red of blood. Because hospital green was recommended for helping reduce the afterimage effect for operating room personnel, the color was applied throughout the hospital assuming other tasks would be aided by its presence. The color worked so well hospitals began painting the color throughout the entire facility. As different finishes were introduced throughout the hospital, all walls remained painted hospital green. Hospital green walls combined with the hospital green scrubs created its own monotonous surroundings (Birren, 1979).

Two University of Washington researchers reviewed researched literature to determine what is empirically known about human response to color with special attention given to color use in the design of NASA space station interiors. They reported the use of “hospital green” to minimize the aftereffects of the operating room staff is a myth. The researchers suggest the hue (color) is not as important to alleviate the afterimage, but the degree of lightness is. They suggest that another hue with the same degree of lightness might work just as well if not better (Wise & Wise, 1987).

Today, with the freedom to introduce other colors in the finishes of the hospital environment, Vernon (1966) suggests designers use more than one color in a room to relieve monotony. To counteract this monotony, he suggests using a color accent wall in the patient room (painting a different color or color with a stronger hue on one wall in the room). The accent wall should be located in view of the patient and preferably the wall facing the patient’s bed. The accent wall would provide variety and relief from monotony in the environment.

To obtain research based knowledge of the effects of color on an individual, researchers record responses to color on polygraphs and electrocephalographs (EEG). One researcher, Brown (1974) determined the response to the color came first from the brain impulse and then the feeling followed afterwards. The brain response to red is arousal and the response to blue is relaxation in both humans and animals. When bright light and warm colors (reds, oranges, yellows) dominate the room, Brown states patients are physically aroused and direct their attention outward to the built environment. A room decorated in cool colors (blues, aquas, and greens) combined with low lighting, leads patients into a restful state. Birren (1979) suggests using the warm, arousing colors for convalescing patients on the way to recovery and maternity patients in need of physical exertion. Warm colors work well in out-patient clinics. The cool colors should be used for long-term patients and those in need of long periods of rest time. Cool colors and low lighting should dominate emergency rooms where patients wait for examinations or tests. Waiting rooms where families wait with anxiety need cool colors to help foster a calming effect. Colors containing yellow-greens should be avoided because reflections from these colors cause the skin to look sallow and unhealthy with an uncomplimentary purple afterimage (Birren, 1979).

In another dimension, Torrice (1989) explored the selection of color through Kirlian photography. Educated in child psychology and design, Torrice lists color as one of three necessary elements in creating a healthy environment. (Choice and convertibility are the other two essentials.) Torrice approaches color as light and not as pigments. When the pigment colors of blue and yellow are combined, green is created. In the visible color spectrum, colors are not combined to create new colors, but each color has its own wavelength. Color is received into the body through the eye gate bouncing off the back of the eye sending impulses to the brain. The brain translates the signals into colors. Torrice states there is research that suggests the body also absorbs color through the skin. Kirlian photography suggests the healthy body emulates a full spectrum of color. Torrice reports people with a handicap lack color in Kirlian photography related to their deficient body function. When Torrice works with clients he uses 8 cards, each card a different glossy color, and asks the client to choose any card. He noted the handicapped client chooses the color card that represents the corresponding color of the handicapped body area that would be missing in the Kirlian photography aura of this client (Torrice, 1989).

Color does have physiological impact. “Color influences the nervous system, respiration, blood pressure, muscle tension, eye blinks, cortical activity and other body functions” (Olds &

Daniel, 1987, p.17). Yet, some studies suggest the physiological responses to color are short and transitory (Carpman & Grant, 1993).

Color can be used to create illusions in the built environment. Warm colors bring the object closer to the eye. Cool colors recede. Whites and yellows leap forward ahead of other colors. Tall ceilings can be lowered with warm tones. Long hallways can be shortened to the eye with warm colors at the end. Rooms can become more spacious with cool, muted colors (Birren, 1979).

Color preferences change with age. Children love the bright reds and blues with sunny yellows. Children under 5 usually recall the color better than the object. As children mature into teenagers, they like color more muted, softer (Olds et al., 1987). As a designer, I have seen that adults tend to choose color based on what they wear well and their personality. Each piece of information on the influence of color helps the designer understand how to create an environment with positive distractions that draws patients out of themselves.

Lighting in the Healthcare Environment

Lighting is another important aspect of the healing environment and has a tremendous influence on color and on the people in the built environment. Carpman and Grant (1993) state that studies show natural light is an essential element to facilitate healing in long-term healthcare patients. The rhythmic changes in natural light provide people stability and order to their lives. Malkin (1982, pp. 273-274) suggests "perhaps the optimal solution to lighting in hospitals would be a system of changing light levels and tints. Since natural light changes throughout the day (warm and rosy at dawn and dusk and bright with a bluish cast at midday), should we not try to imitate these day-night cycles in our built-in environments?" Olds and Daniel (1987) report that radiation from natural light provides light necessary for controlling melatonin, a hormone important in the regulation of biorhythms. The same radiation provides ultraviolet light for skeletal formation and health. As important as this natural light is, care must be taken to balance the natural light streaming into the room with the artificial light in the room. Natural light can be balanced with the installation of artificial lighting opposite to the window wall or by means of window coverings (i.e. window shades) (Olds et al.).

In short-term inpatient and outpatient care natural light is preferred, but not always available. Without natural light special attention must be made to develop lighting that does not add stress to the patient (Birren, 1979). Eriksen (2001) suggests creating a homelike and comforting space in the healthcare environment reduces patient stress. Eriksen states that hospitals in the past did not understand this concept. Direct overhead fluorescent lighting dominated the ceiling and spread shadows that made it difficult to read facial expressions. The effect depersonalized individuals even more. The cool white fluorescent lamps used in the fixtures shed cold unfriendly light and created an impersonal warehouse effect that added more stress to the patient. Olds et al. (1987), report one study around 1980 noted that green paint was a particular problem under fluorescent lights because skin tones start to take on a green tint. Installed in healthcare facility rooms painted in hospital green, fluorescent lighting added stress to the doctor as well as the patient. The architect Eriksen (2001), maintains fluorescent lights should be seen as totally unacceptable as the primary form of lighting in any hospital room.

Positive developments have been made to fluorescent lighting. Fluorescent lamps are available with a full spectrum of color eliminating the cool white illumination of the past. Full spectrum lamps create a brighter, sunnier environment close to the spectrum of natural light. The full spectrum light gives truer skin tones to the patient (“Quality of light”, 2007). This is important to the healthcare staff during an examination. Yet fluorescent lamps alone do not create a homelike environment. In creating a comforting space, ceiling mount fixtures should be accompanied with indirect ambient lighting (Birren, 1979). Well designed ambient lighting creates a relaxed environment. The same ambient lighting can be used to give the patient control over his or her room. When more intense lighting is necessary for examinations or cleaning of the room, the overhead ceiling lights can be switched on (Olds et al., 1987).

Ceilings in the Healthcare Environment

Ulrich (1991, 1997) states that studies suggest healthcare environments can be designed to alleviate patient stress. Different segments of the environment have been cited as important factors in a patient's well being. Wayfinding, the positioning of signs and maps to give directional information, is a very important area to address. The length of corridors, partitioning for a patient's privacy, placement of windows for natural light, furnishing of the patient's room all contribute to the patient's perception of the built environment. Recent studies on these areas have been made and suggestions given for improvement in these areas have been documented (Dilani, 2001; Rubin et al., 1998; Ulrich, 2001). One area that receives little attention in the overall design is the ceiling of the rooms occupied by the patient. And yet, a bedridden patient or patient undergoing treatment or testing is forced to look at a monotonous white ceiling (Horsburgh & Zimring, 2001).

Only in recent years have ceilings gained an institutional look. In the history of architecture ceilings played an important part in the design of a room. In the ancient Near East King Darius built the Royal Citadel at Persepolis around 500 B.C. with coffered ceilings and columns topped by carved figures adding to the beauty and complexity of the ceiling. During

Rome's reigning years 386 B.C. to 250 A.D., Roman architecture included high ceilings painted in geometrical patterns, floral and leaf designs, and flying birds. Sometimes gilded beams were added. In the 12th thorough the 13th century, Gothic architecture stunned the world with the intricacies of fan vaulting covering the ceilings of the great cathedrals. In the Gothic homes, ceilings were usually exposed beams or trusses with plaster and adorned with colorful painted ornament, a blue or green ground with painted gold stars. During the English, Italian, and French Renaissance years, ceilings exploded with color and ornamentation. Painted exposed beams, gilded coffered ceilings, medallions, and scenic patterns created ceilings more ornate than the surrounding walls. During the 8 to 15th centuries, Moorish builders adorned ceilings with intricate geometric patterns, carved wood, and painted ornamentation. In the following years, European and American ornamentation on ceilings became lighter without loosing the coffered ceilings, exposed beams, and painted decorations (Whiton & Abercrombie, 2002).

The birth of modernism bared the ceiling of all decoration. Just before World War II, the Bauhaus in Germany established the concept if the built form has no function, it has no reason to be there. This concept spread throughout Europe and into the United States. Hospitals built after World War II followed the modernist form (Whiton et al., 2002). Designers followed one idea; build an environment to aid hospital staff in fighting disease and sickness. Anything in the built environment that did not have a function was eliminated (Ulrich, 1997). The ceiling evolved into a hovering suspended mass of smoke detectors, sprinkles, HVAC vents, and bright fluorescents lights. One designer suggested the ceiling symbolized injury and destruction pointing to smoke, fire, and repairmen. Patients can keep their eyes down from this engineered ceiling maze until forced to lie on their backs in the bed or on a patient transfer cart (Malkin, 2006).

Becoming aware of the effect of the built healthcare environment on the stress of a patient, designers need to consider changes in the accepted design of today's healthcare facility ceiling. It is my opinion that practical sense dictates the ceiling must remain a suspended structure allowing for economical costs in building, easy repairs and cost-effective remodeling. Moving HVAC and electrical systems to the walls would become costly to install, repair, and remodel. Necessary repairs would interrupt the use of the room for a longer span of time than repairs in a ceiling. Attempts made to install electrical and cabling systems in the floor of office buildings proved inefficient for repairs and restructuring. With the electrical and cabling systems installed in the floor it was required to remove the furniture to change cabling or locate a problem. Left in the ceiling, repairs and restructuring could be made without total interruption of the use of the room.

It is my opinion that it remains the designer's responsibility to create a warm, homelike atmosphere within the confines of HVAC, alarm systems, and fluorescents lights. Designers of the Armstrong Ceiling Tiles for suspended ceilings attempted to address this issue with the development of embossed ceiling tiles ("Armstrong, your ideas", 2007). In my opinion, shapes of leaves, footprints, and trains on train tracks imprinted into the ceiling tile did little to distract the eye from the mechanical components in the suspended ceiling. With no color the bland white embossed tiles created little diversion. Painting the tiles before installation was not an option, as the paint would delete the noise reduction properties of the tile.

Guided by the studies of art on the walls proving to be a positive distraction for a patient, the next step would be to put the art where patients lying on their backs can view the picture. Malkin (2006, p. 116) stated, "A patient's experience can be enhanced by placement of images of nature on ceilings in the procedure room". Another study reported by Diette (2003) reinforced this idea (Diette, et al.). Horsburgh and Zimring (2001) surveyed the experiences of architects (who mainly designed health-care facilities) had when they or a close family or friends of the architect spent time in the hospital. The results revealed an overall idea that patients find the hospital a threatening place and try to make it more familiar and secure. Direct observations from the study stated," Blank ceilings were irritating. Art on the ceiling was pleasant" (Horsburgh et al., 2001, p.167). Ulrich (1991, p.103) reported research by Coss indicated that patients in a presurgical holding room viewing ceiling mounted "serene picture murals (primarily displaying water or other nature) had lower systolic blood pressure than patients viewing arousing art or no picture". Cintra (2001) states that during a post-occupancy evaluation of The Cancer Treatment Centre at Liverpool Hospital, hospital staff revealed patients asked for a different bed at the Renal Dialysis Unit to get a better view of one of the ceiling works. An architect, Eriksen, (2001) asked for patient participation in the design of a new children's wing at the Hillerød Hospital in Denmark. Suggestions noted during the interviews included using decorations on the ceiling of the bedrooms.

Artwork on the ceiling does provide a positive distraction. Yet, the art work must become more obvious than the mechanical and electrical components of the ceiling. Illuminating the art work projects it forward and draws attention. Joey Fisher, a nature photographer, was the first to establish a business with illuminated ceiling art work ("About ARI", 2003). The beginning of the business idea took root when an elderly family member of Fisher lay on his back in the hospital with only a white ceiling to view. Fisher watched his family member look at the ceiling for hours. He determined to find some way to give a patient nature to view from the hospital bed. Fisher developed his photography to fit into the ceiling grid of the existing suspended ceiling. He placed the photograph in the ceiling with a fluorescent light behind it to illuminate the art work. The artwork dominated the ceiling drawing the patient's attention to the nature scene.

Care must be taken in the illumination of art work on the ceiling. Illuminated art work can change the color of the patient's skin making it difficult for the doctor to properly diagnose a patient. The art work can decrease the amount of overall illumination in the room. To eliminate this problem, the art work should be installed so that it is switched separately from the direct overhead lighting used for examinations.

Illuminated art work works well to create a positive distraction for the patient. In my opinion, the next step in the design process is creating a distraction that holds the patient's attention for a longer span of time. I believe this can be achieved by applying movement of color to the art work. Considering the need for artificial lighting to imitate natural light, artificial colored light behind the nature scene can be applied to change from rosy-red tones to simulate the rising of the sun. Golden tones would come next, followed by bright white slowly turning to deep greens and deep blues. The slow changing of the light colors behind the nature scene will create a positive distraction. The addition of twinkling lights to simulate stars at night would allow the artwork to become a comforting source of low light during the long night hours.

Healthcare Facilities for Children

Greater attention is being turned to serving children in the healthcare environment. The establishing of children's rights facilitated focused attention on the effects of the built healthcare environment on children. Children in healthcare have the same need as adults to feel secure in their surroundings. Very little research has been conducted on a child's perception of the healthcare environment, yet children spend a longer length of time in ambulatory visits each year than adults. A study showed an adult exam room saw on average 7,200 visits per year. A pediatric exam room was used on average 5,000 visits per year (Shepley et al., 1998).

Research on adults suggests a correlation between poor design to increased stress levels, anxiety, delirium, elevated blood pressure, and increased intakes of medication (Dilani, 2001; Eriksen, 2001; Rubin et al., 1998; Ulrich, 2001). Shepley (2001) makes the assumption that children are more impacted by the physical environment than adults, and they are impacted in ways different from adults. Children internalize their environment in a way different from adults. Shepley states that research documents children remember places and sensations more than they remember people. Olds and Daniel (1987) suggest children who are sick, injured, or suffering from a disabling condition are usually more affected by their surroundings than healthy children.

Children need an environment that stimulates and gives movement in predictable ways with a moderate amount of change and contrast (Olds et al., 1987). This allows their nervous system to work optimally and gives the child a comfortable, safe feeling. When a child is comfortable in a space, he or she is less self-conscious, confused, or disoriented.

Eriksen (2001) reports that most children have little prior knowledge of healthcare visits. Every element of the visit is something new in their world. This newness can be alarming. Eriksen suggests that two of the main experiences children and parents have in a hospital are waiting and anxiety. The two are connected. Waiting comprises the majority of time spent in the healthcare setting and only adds to the stress of the parent and child. Olds and Daniel (1987) suggest that a sterile, monotonous environment with no positive distractions adds to the existing anxiety. Comfortable settings may lower a child's anxiety making the child more co-operative which allows the parent to relax.

Eriksen (2001) reports that children need an environment that stimulates their interests and entices them to play. She suggests spaces that do not provide for children to be active only increase the anxiety of the child and parent. Children do appreciate and respond well to beauty in well designed rooms that emphasize the importance of the child. Comments made by children about the Hillerød Hospital in Denmark before renovation described the environment as boring. They stated there are no nice colors, no decorations, and no plants. The children wanted homelike surroundings with colors, pictures, plants, and different kinds of decorations. Parents asked for friendly, cheerful, relaxing environments (Eriksen, 2001).

It is my opinion that designers learned from recent evaluations of the pediatric healthcare environment and started transitioning the pediatrics' sterile monotonous environment to a nurturing setting. Using art and color to transform the environment, rooms become stimulating. Still, care must be taken in this transition not to go too far. Shipley, Fournier, and McDougal (1998) caution that the art theme can be comforting or frightening to a child. Children can view circus themes as an unknown threat. Some adults now state when they were children clowns terrified them. Trends in design can be disturbing to children. Graphics of in-fashion heroes or race cars may not appeal to all children.

Again, nature becomes the safe neutral ground in design. Studies suggest that nature in art can substitute for the effects of nature to an individual (Ulrich, 1991). It is my opinion that nature provides the moderate amount of change and contrast, a "difference within sameness" that Olds and Daniel (1987) report is important to give a child a feeling of comfort and contentment. The changes of the seasons, weather, and the cycling of daylight to night provide the differences needed within the same framework.

Even with the use of nature themes care, Shepley et al. (1998) state that care needs to be taken with the proportion of the art in a child's room. One trend has been to distract the child through large proportioned graphics of animals surrounding the door opening of a healthcare facility or holding up the examination table in a pediatric clinic. No studies were found to see if this helps or if the scale frightens the child. Shepley et al. (1998) maintain the design does need to be proportioned to fit in the scope of the child's understanding.

Shepley et al. (1998) advise using natural light for children's patient and waiting rooms. They reported Ross Planning Associates recommended a window sill height of no more than 3' from the finished floor to allow the children to view the outside. Care must be taken not to place the sill of the windows at a height low enough to take away the sense of security necessary for the child. Shepley et al. supported this statement using an incident recorded in a post-occupancy evaluation of the Royal Hospital for Sick Children in Glasgow, Scotland. The evaluation revealed windows placed all the way down to floor level caused all activity in the room to take place at a distance from the windows. The designers wanted to give the children and their parents an excellent view with the hope of providing a positive distraction for them. The windows were locked and the staff had the keys, but children did not play close to them.

Placing windows in the pediatric inpatient room does not eliminate the need for versatile lighting. Shepley et al. (1998) report that Schwartz, a lighting consultant, recommended four types of lighting: reading, night, exam, and ambient light. Ross Planning Associates gave the following lighting requirements. The lighting at the bed should be 100 foot-candles and controlled by a dimmer. The examination light should be 150 foot-candles 12" from the source of light. The reading and activity center light should be 30 foot-candles and the night light 3 foot-candles 1' from the source at the floor. The lights should be controlled at the patient bed.

It is my opinion that the design of the ceiling should be addressed for pediatric patients. Children undergoing testing and examination are particularly vulnerable to stress and anxiety (Shepley, 2001). Malkin (2006) urges designers to create design that lifts the spirit. Again, it is my opinion that today children's healthcare facilities can combine technology, color and artwork to delight and educate children. Design needs to embrace color, and art with innovative lighting techniques.

CHAPTER 3

RESEARCH METHODOLOGY

Introduction

The null hypothesis of this research states that a light image unit installed in the ceiling of a patient's room would have no effect on the anxiety level of the patient during a medical examination or procedure. To test this hypothesis, the researcher developed a light image unit to install in the ceiling of a pediatric outpatient clinic. The design of the light unit was developed in four stages. In the first stage, the concept of painted ceiling tiles combined with fiber optic lighting won an honorable mention award in a National Cooper Lighting Contest. The second stage solidified the first concept into a fiber optic light unit with 3-dimentional effects. The third concept adapted the unit to a pediatric care facility. The forth concept embraced the newer lighting technology of LEDs and eliminated the use of the fiber optic lighting.

After the development of the light image unit, the researcher consulted two faculty members at East Tennessee State University (ETSU) in Johnson City, Tennessee to assist in forming a method for testing the hypothesis. From the consul of the faculty members, the researcher devised a randomized, balanced, controlled study using four pediatric patient examination rooms. Two questionnaires were developed for collecting quantitative data to test the null hypothesis. The questionnaires collected information from the attending physician and the parent or guardian of the patient related to their perception of the level of anxiety in the child.

Permission to install the independent variables for testing in four examination rooms in the ETSU Pediatric Outpatient clinic in Johnson City, TN was granted by the clinic's manager.

The researchers obtained certification in the Human Subject Training Program and began collecting data in May 2007.

Light Image Development

Concept 1

The idea of using a positive distraction in a pediatric examination room ceiling to assist in lowering a patient's anxiety germinated during the emergency care of my 16-year old son diagnosed with appendicitis. He lay on a table in a darkened room in pain waiting for an emergency appendectomy. Too ill to sleep he lay staring at a cold white ceiling. I would have given much to help alleviate his anxiety. Eight years later in March 2000, I was assigned a project with a partner in an Interior Design class to develop a design for a pediatric clinic healthcare facility. I remembered what my son experienced waiting for a diagnosis and then for an emergency operation. I decided to design a decorative ceiling to alleviate a patient's stress during medical procedures. Although I had conducted no literature research at this time, the literature does suggest that using a positive distraction will assist in lowering stress in a patient and in the patient's family (Ulrich, 1997, 2001; Ulrich et al., 2006; Wells-Thorpe, 2001).

This idea of a decorative ceiling for the design class project grew into the concept of a suspended ceiling tile painted with a characteture of a firefly. The concept was illustrated by building a 12" x 12" (30.48 cm x 30.48 cm) model using foam core board bought at Michaels (Irving, Texas). The look of a suspended ceiling was created by dividing the 15" x 15" (38.1 cm x 38.1 cm) square into 25 equal sections using a T-square and pencil. The look of the fluorescent light lens was created by cutting 4 – 3" x 3" (7.62 cm x 7.62 cm) squares from a thin white plastic sheet and gluing the squares inside 4 of the penciled grid lines. The look of the exposed tee system (the medal grid that holds the suspended ceiling tiles) was created by placing white 1/8" (3.175 mm) wide architectural tape bought at OfficeMax (Naperville, Illinois) on top of all penciled lines. Tree branches and fireflies were painted on the foam core board. The body of the firefly was cut from the foam core board and a piece of thin clear plastic inserted to simulate a recessed can light. The board was framed in a black plastic picture frame with a depth of 1.5" (3.81 cm). A 50-light string of programmable Christmas tree lights were placed between the painted ceiling on the foam core board and a cardboard frame back. The Christmas lights were programmed to slowly fade in and out at random to simulate a fiber optic light with a color wheel. Three of each color of Christmas lights on the same sequence of fading in and out were bundled together and placed in front of the clear plastic sheet that covered the hole cut in the firefly's body. Aluminum foil was placed around each bundle to block the light from the remaining Christmas lights in the back of the frame. The fireflies' body then glowed with a colored light fading in and out mimicking the light of a firefly (as shown in *Figure 1.*). The fading lights were anticipated to attract and hold the patient's attention.

This concept won an honorable mention award on the national level in the Cooper Lighting Contest of June 2000.

Figure 1. Firefly Ceiling, Concept 1

Concept 2

The concept of a decorative ceiling design to provide a positive distraction lay dormant until 2005. In January 2005 I participated in a graduate school class team where we were asked to develop a business concept that could be scaled into a profitable business plan. The team made the decision to pursue the concept of developing a positive distraction to be installed on the ceiling in a healthcare facility to assist in alleviating stress in a patient. One professor in the class suggested using a three-dimensional lenticular lens in front of the art work to create depth and make the art more interesting. Using the lenticular lens created a product consisting of a picture with a three-dimensional effect and backlit with a fiber optic light.

A model of this 3-D back-lit image was constructed and mounted in a 14" wide x 22" high x 1" deep (35.56 cm x 55.88 cm x 2.54 cm) white picture frame. Instead of the original concept of a painted ceiling tile, a photograph of a scenic mountain view (as shown in *Figure 2.*) was selected. Although no literature research had been conducted at this time, literature supports using a restful nature scene to assist in lowering a patient's stress (Carpman et al., 1993; Cintra, 2001; Malkin, 2006; Shepley et al., 1998; Ulrich et al., 2006). Once the photograph was selected, it needed special preparation to facilitate the 3-D effect.

The special preparation entailed using Abode Photoshop to cut the jpeg image of the photograph into six pixel layers with the objects in the foreground (closest mountains and clouds) overlaying

Figure 2. Mountain View, Concept 2

the objects in the background (the farthest mountain and clouds). The middle mountains and trees were divided into the remaining four layers and placed between the foreground and background. The picture was saved as a mix file. These layers prepared the image for the next step, interpolating the picture using Image Contour™ software (Atlanta, Georgia). To interpolate the picture, Image Contour™ cut each layer of pixels into strips. The strips were interlaced by laying the first strip of layer 2 adjacent to the first strip of layer 1, the first strip of layer 3 adjacent to the first strip of layer 2, etc. This procedure continued until all strips were interlaced. The size of the strips was chosen to match the size of the pitch of the lenticular lens used. The number of lens per inch determines the pitch of the lenticular lens. The pitch determines the optimum viewing distance from the 3-D picture. The 40 lens per inch (lpi) pitch was chosen for this project establishing the optimum viewing distance at 6 to 10 feet.

The lenticular lens was obtained from Micro Lens in Charlotte, North Carolina. The lenticular lens was created by molding the front of the plastic sheet into parallel rib-like rows or lenses. Each lens has a cylindrical shape that lines up with the strips in an interlaced picture. As the picture behind the lenticular lens is viewed, each layer of the picture (back mountains and clouds, middle mountains and trees, etc.) is seen from a slightly different angle creating a three-dimensional effect and giving the picture depth and interest.

After the photograph was interpolated for a lenticular lens, printing was the next step. The photograph was printed on vellum using a CAD (computer aided drawing) plotter located in the office of an architect in Johnson City, Tennessee. Vellum was chosen to allow light from the fiber optic cable to filter through the picture and lenticular lens. The photograph on vellum was adhered to the back of the lenticular lens. (The lenticular lens was manufactured with an adhesive applied to the back of the plastic for securing printed material to the plastic.) Great care was taken to align the strips in the interpolated photograph with the lens in the plastic to create a clear picture.

Once the photograph was adhered to the back of the lenticular lens, it was placed in a 22" wide x 14" high x 1" deep (55.88 cm wide x 35.56 cm high x 2.54 cm deep) white picture frame. A box, 22"wide x 14" high x 6" deep (55.88 cm wide x 35.56 cm high x 15.24 cm deep), was built using foam core board purchased from Michaels. The box was attached to the picture frame with hot glue. An ice pick was used to puncture holes in the back of the foam core board box to allow the fiber optic light cable (Del Lighting, San Antonio, Texas) to be pushed into the box. The cable containing the strands of fiber optic fibers was split into smaller bundles of fiber optic fibers, each bundle containing 10 to 15 strands. The bundles of strands were pushed through the holes behind the picture. Hot glue was used to secure the strands to the box. The end of the fiber optic cable opposite the picture box was installed in the housing box containing the halogen light source and color wheel per manufacturer's directions. The housing box contained the electrical connection, a NEMA 5-15P (a 2-blade, 1 ground plug for a 125v/15amp receptacle).

The light at the end of the fiber optic cable was generated by a halogen light located in an 8' x 12" x 6" (20.32 cm x 30.48 cm x 15.24 cm) housing. The housing contained a color wheel divided into four colors (red, blue, green, and yellow) and located between the halogen lamp and fiber optic cable. A small motor slowly turned the color wheel changing the color of the light transmitted from behind the picture. The concept was to capture the patients' attention with the slowly changing colors distracting them from the medical procedure.

Concept 3a

The development of the light image continued toward commercial development with anticipation of being placed in a pediatric clinic. The decision was made to reproduce the model's specifications using the lenticular lens and fiber optic lighting. The picture of the mountains was not suitable for the pediatric clinic. Microporus (Johnson City, Tennessee) had on file a computer generated picture of an aquarium containing colorful clown fish and other brightly colored salt water fish (as shown in *Figure 3.*). The picture fit perfectly with the pediatric clinic's seashore theme painted on the walls in the waiting area. At this time no literature research had been conducted, yet literature supports the use of restful, non threatening nature scenes for a positive distraction to assist in alleviating stress in adult and pediatric patients (Carpman et al., 1993; Cintra, 2001; Malkin, 2006; Ulrich et al., 2006). The literature supports that young children chose bright and cheerful colors for their surroundings (Eriksen, 2001; Olds & Daniel, 1987).

Figure 3. Aquarium Picture, Concept 3a

After selecting the aquarium picture, the process for printing the image for the lenticular lens started. The vellum paper that the mountain scene was printed on was not suitable for the 2'x4' (60.96 cm x 121.92 cm) aquarium image and the plotter was not capable of printing a high quality print in the 2'x4' format. The file was taken to Essyx Printing in Johnson City, Tennessee. A back lit paper was chosen to use for the picture that would allow the fiber optic light to shine through. This time care was taken to match the printing process with the interpolation of the picture. This was accomplished by printing a file containing a set of lines for each variation of the 40 lpi pitch. The printed page containing the set of lines was placed under the 40 lpi lenticular lens and the lines that matched the closest appeared completely black. It was determined the printer would print the image at 40.01 lpi. The image, interpolated @ 40.01 lpi, was printed and mounted onto the lenticular lens sized to fit a 2' x 4' fluorescent light troffer (Lithonia, Conyers, Georgia). To complete the prototype, the plastic light lens on the 2' x 4' fluorescent fixture was discarded. The fluorescent light fixture's sockets, ballast, and wiring were removed. Thirty inches of the black sheath surrounding the fiber optic cable was stripped off. The exposed strands in the fiber optic cable were divided into bundles of 10 to 15 strands. One-half inch holes evenly dispersed were drilled into the back of the fluorescent light troffer. The fiber optic light strand bundles were pulled from the outside back of the troffer to the inside. The opposite end of the light cable was connected to the light box housing containing the color wheel and light source per manufacturer's instructions. The picture mounted on the lenticular lens was placed in the metal grid on the front of the fluorescent light troffer. Once the fiber optic light was switched on, the fiber optic strand bundles were pulled in and out of the light troffer to determine the optimum distance of the light strands from the picture.

The fluorescent light troffer containing the picture (the light image) was taken to the pediatric clinic for installation. A switched duplex outlet had been installed by a licensed electrician to accommodate the fiber optic light. The outlet was located 12" (30.48 cm) down from the suspended ceiling grid and directly above a duplex outlet located 6" (15.24 cm) above the countertop in a pediatric examination room. A wall switch was installed 6" (15.24 cm) above the lower duplex outlet to switch the outlet closest to the ceiling. A ceiling tile located directly over the head of the examination table was removed from the grid. The fluorescent light troffer was installed in the opening. Care was taken to check the support of the grid in this area. It was determined that the wire supports were close enough to the light fixture to provide adequate support. The fiber optic cable was run from the fixture across the plenum (the space above the suspended ceiling) to the wall containing the switched duplex outlet. A small hole was cut into the ceiling tile at the wall edge of the ceiling and the cable was pulled through this hole. The fiber optic light housing was placed on the top of the wall cabinet located below the switched outlet. A ceramic tile was placed under the housing to ensure the heat from the halogen light in the housing would not damage the wall cabinet. The fiber optic cable was connected to the housing per manufacturer's instructions. A decorative castle, a replica of the castle in the 3-D light image in the fixture, was built from a non-combustible material and place in front of the fiber optic light housing. The castle had been built large enough to camouflage the housing and the cable running from the ceiling to the housing.

This prototype was installed in an examination room in the East Tennessee State University's Physician's Pediatric Clinic in Johnson City, Tennessee. The ceiling light image was enjoyed by the children, their parents, and the medical staff. The lenticular lens created a great depth in the picture, but the fiber optic light did not produce enough light to illuminate the picture when the ceiling fluorescent lights were switched on. The medical staff switched the overhead fluorescents off to help attract the patient's attention.

Concept 3b

The light image did not have the required intensity. An investigation started to find an alternative light source. J. Paul Sims, a professor in the Engineering Technology department at ETSU, suggested LEDs (light emitted diodes). The LEDs offered major improvements in the light image design. The fiber optic light generated more heat than the LEDs; required the color wheel and outside housing for the light source; required a fiber optic cable run from the light fixture to the housing; and had an expected 2,000 hours of halogen lamp life. The LEDs were contained in the light image fixture, were available in red, blue, and green colors programmed to slowly change from one color to the next, produced less heat than the halogen lamp in the fiber optic housing, and had an expected 50,000 hours of diode life.

The LEDs were available as 12” x .825” (30.48 cm x 2.1 cm) light bars with 36 (12 each of red, blue, and green) LEDs. Seven RGB-2 series 36-LED light bars, one RGB-2 Controller, and one 24w RGB2-PS24/J transformer with a NEMA 1-15P (a 2-blade plug for a 125v/15amp receptacle) were purchased online from Superbrightleds.com. The RGB-2 light bars contained red, blue and green LED’s and were programmed to slowly change the light color.

The next step in the design process was to ensure an even distribution of light emitted from the LEDs behind the picture. A LED light bar was connected to a low voltage transformer plugged into a power outlet. The illuminated light bar was held by hand behind the picture mounted on the lenticular lens. Pinpoints of light from the LED appeared through the front of the light image. Moving the LED further away from the lenticular lens did not diminish the sharp points of lights. Two ideas, using a Fresnel lens or using a frosted paper backing behind the picture, were tried without success to evenly diffuse the light. It was discovered that by positioning the LED light bars in the bottom of the fluorescent light troffer, the troffer diffused the light from the LEDs. Once this discovery was made, the LED light bars were installed in the light troffer by an experienced electrical engineer (as shown in *Figure 4*.)

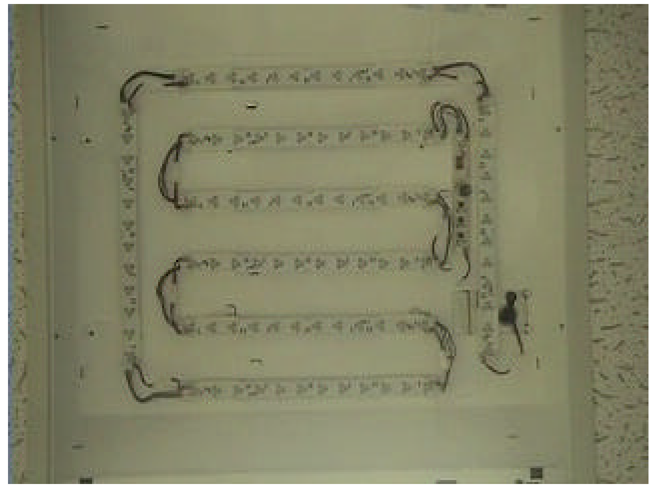

Figure 4. Installation of LED Light Bars, Concept 3b

A switched duplex outlet was installed by a licensed electrician in the plenum above the suspended ceiling directly above the first installed outlet. The new duplex outlet shared the switch with the duplex outlet installed for the first prototype. Care was taken to install the outlet within the boundaries of the electrical code for healthcare. The electrical cord from the transformer mounted in the troffer with the LEDs was plugged into the electrical outlet.

Using the LEDs eliminated several problems encountered with using the fiber optic light source that included heat from the lamp and positioning the housing. The fiber optic light source used a halogen lamp installed in a metal housing. The heat produced by the halogen lamp required air space around the housing to eliminate overheating. The housing could not be placed in the plenum or inside a small enclosure (i.e. inside a wall cabinet). The only remaining place to position the housing was in an open space in the room. This placement introduced unwanted noise (from the color wheel motor), heat (from the halogen lamp), and light (from the housing) in the examination room. The LEDs were contained in the light troffer and produced an insignificant amount of heat.

Containing the LEDs in the troffer created another major improvement. The light troffer was easier and more cost effective to install. More options were available on positioning the light image in the suspended ceiling. The light image fixture was easier to design and build, and as the design of LED's improves, the improvements can be easily incorporated into the light image fixture.

Design of the Test Environment

After the development of the light image, an experiment was developed to disprove the null hypothesis. The experiment developed from reasoning that reduction of stress in the pediatric patient should allow the physician to complete the patient's examination in less time and lower the stress in the attending parent or guardian. Physiological data (i.e. blood pressure, blood, and saliva tests) would yield the most accurate quantitative data to test this postulation. Because this testing would compel using an invasive procedure on children, it was determined that for this experiment these type of tests were not feasible. To evaluate non-invasive measurements to generate quantitative results, the researchers developed two post-exam surveys with the assistance of Wallace Dixon, Department of Psychology Chairperson at East Tennessee State University. The method Dixon recommended to measure the effect of the light image on the patient included two independent variables, a negative control and a positive control.

The first independent variable specified installing the light image with the aquarium picture backlit with LEDs in the ceiling of a patient examination room. The second independent variable specified installing the identical aquarium picture used in the first independent variable with no LED backlighting in the ceiling of a patient examination room. The negative control specified placing a 2’ x 4’ (60.96 cm x 121.92 cm) square of black poster board (Michael’s, Irving, Texas) to simulate the same size as the light-image unit (negative space) in the ceiling of a patient examination room. The positive control included a patient exam room with no changes to the ceiling. The light image, image with no backlighting, and the black poster board were located in the ceiling grid directly above the patient’s examination table.

The design of this research modeled the method discussed in the Literature Review cited by the John Hopkins Team as the best methodological research; a randomized controlled study. (Rubin et al., 1998)

Design of the Survey Instrument

After developing the test environment, the researchers asked the manager of the East Tennessee State University Pediatric Clinic in Johnson City, Tennessee, for permission to conduct the survey. Permission was granted; patient rooms were assigned for the study; and the light image unit, image without the backlighting, and black poster board square were installed in the rooms.

The next step required creating two survey instruments designed to collect quantitative data to test the null hypothesis. Wallace Dixon, and W. Andrew Clark, were consulted to determine what information would be collected via the survey instruments. Data collected would be used to determine if there was a reduction of stress (treatment effect) in the patients examined in the room with the light image unit. A reduction in stress should lead to the physicians having an easier and shorter examination time. The questionnaire for the physicians asked how much time was spent on the examination, the ease of the examination ranging from very easy to very difficult; and if this was a sick or routine visit. Because this was ordinal level data, the Kruskal-Wallis non-parametric was used to analyze data collected by this survey instrument.

The second survey instrument was used to collect information from attending parents or guardians to measure their perception of the room and stress level of the patient. The parent or guardian survey instrument collected information related to the sex and age of the child, the parent or guardian's perception of the room, the length of the examination, and how the parent or guardian perceived the anxiety level of the patient during the time in the examination room. These data were linear in nature and were analyzed using regression analysis.

The survey instruments were developed to be brief so as not to be cumbersome to the physician and to the parent/guardian, yet were adequate to collect the necessary information to test the null hypothesis. The Physician and Parent or Guardian survey instruments are listed in Appendix A and Appendix B.

Data Collection

Prior to data collection and evaluation of the light image unit, all members of the research team received certification in the Human Subject Training Program. This training instructed the researchers how to take part in the survey with sensitivity to respect and protect the privacy and well-being of the people surveyed. After the training, the survey instruments were submitted to the IRB Board of East Tennessee State University for approval. Approval was granted and the collection of data began in May 2007.

To follow the randomized controlled study methodology, medical staff were assigned to the test examination rooms at random. No attempt was made to direct the patient assignments by the researchers and no information was given to the medical staff on the reason for the survey.

When a patient was assigned to one of the four examination rooms, the researcher placed the physician's questionnaire in the chart holder on the examination room's door. At no time did the researcher open or view the patient's chart. After the attending physician examined the patient and left the examination room, the physician completed the survey instrument for physicians and handed it to the researcher. The researcher recorded the number of the examination room and the code number for the attending physician on the back of the questionnaire. The researcher then waited until the nursing attendants finished their duties with the patient before knocking and entering the examination room. Once in the room the researcher discussed with the parent or guardian the informed consent as required by the IRB and asked for their consent to complete the parent or guardian survey instrument. After the survey was completed in the room containing the backlit light image, the researcher asked the parent and patient's reaction to the light image on the ceiling. All comments that were made are listed in their entirety in Appendix C.

Statistical Analyses

Statistical analyses were conducted using standard software programs from SPSS (Chicago, IL) and Statistical Analysis System (SAS, Cary, NC).

Data from the physician survey instrument were non-linear or ordinal (the set of observations could only be ranked) and, therefore, not capable of being analyzed using standard analysis of variance (measurement of the spread of the data) and regression (predicting variables by finding the best fit line through known plotted variables). The nonparametric Kruskal-Wallis test (applied when data are not normally distributed and variances are different from each other) was used to determine if treatment effects (backlit light image, non-backlit light image, black square, standard examination room) were evident for the dependent variables examined. Variables of examination time (time of exam in groupings of minutes) and characterization of the exam (compliance of patient as assessed by the physician) were evaluated.

Data from the parent or guardian survey instrument were analyzed using regression analysis (Proc GLM, SAS) and differences between means were determined using Tukey's Standardized Range Test. The model used for the effect of treatment on dependent variables patient anxiety, perception 1 and perception 2 was:

Y_{ij} = mean + $?_i$ + Error $_{ij}$

Where:

Y = each variable measured, and

?= treatment (examination room) effect

An additional test was run to determine if co-variables (age of patient, sex of patient and length of examination) significantly affected the model. For this analysis the model used was:

$Y = ß_0 + ß_1X_1 + ß_2X_2 + ß_3X_3$ + error

Where:

X_1=age of patient, X_2=sex of patient and X_3=length of exam.

CHAPTER 4

RESULTS

Physician's Survey Instrument

Data from two variables (identified by questions 2 and 3 in the Physicians' Survey Instrument) (Appendix A) were analyzed. Question 2 surveyed the length of the examination time and question 3 surveyed the ease of conducting the exam as assessed by the physician. Question 2 grouped the examination time with answer choices of less than 10 minutes, 10-20 minutes, 20-30 minutes, 30-45 minutes, and 45-60 minutes with less than 10 minutes assigned the number 0 and 45-60 minutes assigned the number 4; intermediate times were assigned consecutive numbers. Analyses of question 2 data showed a significant treatment effect (p=0.008) in the length of examination time. Because information in the survey is ordinal level data, treatment means are not appropriate methods of comparison. Median values for each treatment give an approximate estimate of treatment effects. Results (Table 2) indicated all treatments had the same median (examination time = 10 to 20 minutes). Table 1 lists the median rank for Physician's Survey Instrument question 2.

Table 1

Effect of Treatments on the Examination Length Recorded by the Physicians

Treatment	Number of Observations	Median
Backlit light image	20	1.00
Standard examination room	20	1.00
Black ceiling square	20	1.00
Non-backlit image	20	1.00

Note: Kruskal-Wallis Test: Ranks

Score 0 median = less than 10 minutes

Score 1 median = 10-20 minutes

Score 2 median = 20-30 minutes

Score 2 median = 30-45 minutes

Score 4 median = 45-60 minutes

Question 3 from the Physician's Survey Instrument grouped the character of the examination into five categories; very easy, easy, average, difficult, and very difficult with very easy assigned the number 0 and very difficult assigned the number 4; intermediate times were assigned consecutive numbers. Analysis of data from question 3 showed a significant treatment effect (p=0.032). The significance only states there is a difference in the treatments but does not identify what that difference is. Because information in the survey is ordinal level data, treatment means are not appropriate methods of comparison. Median values for each treatment give an approximate estimate of treatment effects. Table 2 lists the median rank for question 3.

Table 2

Effect of Treatments on the Characterization of the Examinations (compliance of patients as assessed by the physicians).

Treatment	Number of Observations	Median
Backlit light image	20	1.0
Standard examination room	20	1.0
Black ceiling square	20	1.0
Non-backlit light image	20	2.0

Note: Kruskal-Wallis Test: Ranks

Score 0 median = very easy

Score 1 median = easy

Score 2 median = average

Score 2 median = difficult

Score 4 median = very difficult

Parent or Guardian Survey Instrument

Data from three variables in the patient/guardian survey instrument were analyzed. The variables were identified by questions 3a, 3b, and 5-6 on the survey instrument (Appendix B). Question 3a (perception 1) asked the parents or guardians to assess their perception of the examination room as boring, interesting, or some point between boring and interesting. A measurable linear scale of 0.5 for boring to 5.5 for interesting was designated to measure the assessment. Using regression analyses, Perception 1 showed no statistical difference for treatment effect ($p= 0.3601$). Treatment means as determined by Tukey's Studentized Range are in Table 3.

Table 3

Effect of Treatments on the Paren or Guardian Perception 1 of the Examination Rooms

Treatment	Number of Observations	Mean[1]
Standard Examination Room	20	4.2375[a]
Backlit light image	20	4.2125[a]
Non-backlit light image	20	3.6875[a]
Black Ceiling Square	20	3.6000[a]

Note: Tukey's Studentized Range (HSD) Test for Perception 1 with Range of 0.5 for Warm and Comforting to 5.5 for Cold and Unfriendly.

[1] Means with same superscript are not different (p = 0.3055)

Question 3b (Perception 2) asked the parents or guardians to assess their perception of the examination room as warm and comforting, cold and unfriendly, or some point between warm and comforting and cold and unfriendly. A linear scale of 0.5 for warm and comforting to 5.5 for cold and unfriendly was developed to measure the assessment. Using regression analysis, the variable Perception 2 showed no statistical difference for treatment effects (p= 0.3955). Treatment means as determined by Tukey's Studentized Range are shown in Table 4.

Table 4

Effect of Treatments on the Parent or Guardian Perception 2 of the Examination Rooms

Treatment	Number of Observations	Mean[1]
Non-backlit light image	20	1.9625
Black Square	20	1.687
Standard Examination Room	20	1.5875
Backlit Image	20	1.3625

Note: Tukey's Studentized Range (HSD) Test for Perception 2 with Range of 0.5 for Warm and Comforting to 5.5 for Cold and Unfriendly.

Question 5 and 6 (Anxiety 2) asked the parents/guardians to assess their perception of the patient's anxiety level during the time spent in the treatment room including the physician's examination time. A linear scale of 0.5 for not at all anxious to 5.0 for highly anxious was designated to measure the assessment. Using regression analysis, the variable Anxiety 2 showed a statistical treatment effect (significance, p= 0.0234). Treatment means as measured by Tukey's Studentized Range are shown in Table 5. A statistical difference between treatment means was determined for the room with the black ceiling square and the room with the non-backlit light image. Although not statistically significant, it is interesting to note that the patients in the rooms with the backlit and non-backlit light images tended to be less anxious (numerically) than the patients in the standard examination room and the room with the black ceiling square.

Table 5

Effect of Treatments on the Parent or Guardian's Assessment of the Anxiety Level of the Patient During the Time in the Examination Rooms

Treatment	Number of Observations	Mean[1]
Black Square	20	2.4500[a]
Standard Examination Room	20	2.4125[ab]
Backlit Light Image	20	1.8000[ab]
Non-backlit Light Image	20	1.3625[b]

Note: Tukey's Studentized Range (HSD) Test for Anxiety 2 with Range of 0.5 for Not At All Anxious to 5.0 for Highly Anxious.

[1] Means with superscript [a] and superscript [b] are statistically different ($p = 0.0234$)

Covariate analysis was conducted to determine if the covariables (age of patient, sex of patient, length of examination time) had significant interaction with variables perception 1(parent or guardian's perception of room from boring to interesting) and perception 2 (parent or guardian's perception of the room from warm and comforting to cold and unfriendly).

Length of examination time but not age or sex of the patient demonstrated significant interaction with the variable perception 2 (p=0.0027) but not perception 1 (p=0.1087). The covariate examination length was then included in the statistical model in an attempt to remove explained variation from the model such that treatment effects could be examined more accurately. Results from including the covariate in the model indicate that there is not an observed treatment effect for perception 1 for either the model including the covariate (p=o.3613) or not including the covariate in the model (p=0.3955).

CHAPTER 5

DISCUSSION

Peoples' opinions and emotions are the hardest elements to evaluate correctly in a controlled environment. When evaluating the emotions of children, assessment tools must be carefully chosen to protect the child physically and emotionally. A number of different methods were evaluated for determining if including the backlit light image in a pediatric examination room would have an effect on the patient's stress level. Techniques such as taking the patient's blood pressure before, during, and after the examination; collecting a saliva sample to measure stress hormones in the patient; video taping the examination (with permission from the parent or guardian and physician) to determine how often and how long the patient looked at the backlit light image; or viewing the examination (with permission from the parent or guardian and physician) and recording the physical movements of the patient were potential options to evaluate the patient's comfort level in the exam room. These options were considered too invasive or required more resources than were available for this study. The decision was made to assess the patients' anxiety and the physicians' ease of examination using a survey instrument. Although the survey instrument provides a mechanism for data collection; the differences in how the parents or guardians perceive their surroundings, how the patients felt during the examination, how well the parents or guardians comprehended the questions asked on the survey instrument, and the experience of the physician conducting the examination added variation to the research data that was difficult to account for in the statistical model.

Physicians' Survey Instrument Data

The attending physician recorded the length of the patient examination (time in minutes) and the characteristic of the examination (very easy to very difficult). Analyses of the data showed a significant treatment effect (p=0.008) for the variable examination length. Although the data analysis show a significant treatment effect, the precision of this model does not identify where these differences lie. Because the data were ordinal and data means are not relevant, medians are reported. The results showed no difference in the median of the treatments (median = 10 to 20 minutes). Although there is a treatment effect, the variable creating the effect cannot be identified with the data analysis.

The attending physician recorded the characteristic of the examination (very easy, easy, average, difficult, and very difficult). Data analysis showed a significant treatment effect (p=0.032) for the variable examination ease. Because the data are ordinal, data means are not relevant, so again the data median are reported. The results show that medians for the backlit light image, standard examination room, and black ceiling square scored an easy examination while the median for the non-lit light image scored an average examination ease.

In reviewing the data results, there is one extraneous variable to be considered. The data were obtained from 14 physicians ranging in experience from residents new in the program to the attending teaching physicians. When no residents were present for the examination, the teaching physician conducted the examination and recorded the data. When residents were present, the resident conducted the initial examination and recorded the data. In reviewing the recorded physicians' survey instrument, the data showed an experienced teaching physician recorded 15 out of 20 observations for the backlit light image, 16 out of 20 observations for the standard examination room, 13 out of 20 observations for black ceiling square, and 4 out of 20 observations for the non-backlit light image. It must be noted that the more difficult examinations were conducted in the non-backlit light image room. The lack of the physician's experience may have contributed to the difference in the ease of the examination as indicated by treatment medians.

With the analysis of the data from both examination time and characteristics showing significance, it is difficult to isolate the effect of the treatment from the existing extraneous variables. With these considerations, the researcher cannot reject the null hypothesis on the basis of the significance in the data from the Physician's survey Instrument.

Parent or Guardian's Survey Instrument Data

Parents or guardians were asked to assess the examination room as boring to interesting and regression analysis of the data showed no significant treatment effect (p=0.3601). Numerically ranking the data means, the rooms with the back-lit light image and the standard examination room were identified as the most interesting, while the room with the non-backlit light image ranked third and the black ceiling square was ranked least interesting.

Parents or guardians were asked to assess the examination room as warm and comforting or cold and unfriendly and regression analysis of the data showed no significant treatment effect (p=0.3955), but again there was a numerical difference in ranking the means identifying the room with the backlit image as the most warm and comforting. This agrees with the literature review that nature art creates a comfortable, relaxing environment for patients and their families (Cintra, 2001; Dilani, 2001; Olds & Daniel, 1987; Shepley et al., 1998; Stouffer, 2001).

Regression analysis of the parent or guardian's perception of the patient's anxiety during the time in the examination room showed a significant treatment effect (p=0.0234). Treatment means were significantly different between the non-lit light image room (the lowest patient anxiety level) and the black ceiling square room (the highest patient anxiety level). The null hypothesis that a light image unit installed in the ceiling of a patient's room would have no effect on the anxiety level of the patient during a medical examination or procedure cannot be rejected because the backlit image room was not statistically different from the other test rooms.

However, evaluating the parent or guardian's perception of the patient's anxiety during the time in the examination room pointed to an interesting trend. Regression analysis indicated a significant trend for treatment effect (room) on patient anxiety level. Treatment means showed a statistical difference between the black ceiling square and the non-backlit image. Numerically, patients in the room with the black square showed the greatest amount of anxiety, patients in the non-backlit light image room and backlit light image room showed the lowest level of anxiety, while patients in the standard examination room ranked third in their level of anxiety. Our data agree with the literature that a positive distraction of nature art in the healthcare environment suggests a reduction in the patient's level of anxiety and stress (Carpman et al., 1993; Cintra, 2001; Malkin, 2006; Ulrich et al., 2006).

CHAPTER 6

CONCLUSION

The trend in this data analysis suggests that a positive distraction of art in the room numerically lowers patient stress and suggests that more research in this area is needed. However, several elements in this research need to be addressed and modified for future research.

The Physician's Survey Instrument questions 2 and 3 (Appendix A) from this research contained questions that produced only ordinal data and had results that are often times difficult to interpret. In future research using questions that result in linear measurable responses would allow the researcher to obtain more information statistically from the data base. The Patient's Survey Instrument (Appendix B) questions 4 and 5 asking the parent or guardian's perception of the patient's anxiety were confusing. Question 5 asked if the purpose of the visit to the doctor (well child check-up, specific illness) was the first time for the patient. Question 6 asked if the patient was returning for the same reason as a previous visit. Some parents or guardians answered both questions on the survey instrument, some answered just question 4 while others answered only question 5. On the survey instruments that had questions 4 and 5 or only question 4 answered, the researcher used the data from question 4. On the surveys with only question 5 answered, the researcher assigned question 5 numerical values that corresponded with the linear scale in question 4 to use in the analyses of data.

The sample of this research was limited to one clinic in a small city in Tennessee. The majority of patients visiting the clinic were from one social and economic stratum. Future research might be conducted in several outpatient clinics from different social structures to obtain a more universal sampling of the population.

Another element identified during this research regarded the position of the backlit light image and how might it be best positioned for optimum interaction with the patient. The assumption was made by the researcher that the pediatric patients would lie down on the table for the examination. The majority of patients in this clinic were not required to lie down with their face oriented toward the ceiling for physician examinations. Although many patients did lie back on the examination table just to view the light (see Appendix Ca; Comments from parents or patients on the backlit light image), the patient faced the room's wall during the majority of time spent in the examination room. Future research in a pediatric out clinic may obtain different results by installing the backlit light image on the wall directly in front of the examination table. A pediatric hospital room may be a more appropriate application for a ceiling mounted backlit light image.

In future research the experiment should be designed to reduce as much variation as possible. Potential changes in the experimental design might include sampling of the physicians' perception of the patient to be limited to two physicians of equal experience. Data taken from well and acute patients would be analyzed separately or the study could be narrowed to include only well or only acute patients.

To produce data more precise than a physician's or parent or guardian's perception of stress in the patient, a sample of saliva would be taken before the patient entered the examination room and during the doctor's examination to analyze the cortesol level, a hormone that increases in response to stress. To test the stress level of the patient without invasive measures, the examination would be filmed (with parental, guardian, or physician consent) and observation of eye movement on or away from the backlit light image or arm and leg movements would be documented for analysis.

The written observations by Nightingale (1860) followed by Ulrich's (1991, 1997, 2001) pioneer research into the need for nature or nature art as a positive distraction in the healthcare environment, substantiates the numerical trends seen in this research data. Positive distractions of nature or nature art assist in lowering stress in the patient and should be considered as a design element in various medical facilities.

In recent years companies started supporting this trend by investing large amounts of capital into developing and marketing the art of nature as a positive distraction to help assist in lowering a patient's stress. Art Research Institute, Ceiling Scenes, and the Sky Factory are all commercial entities that offer beautiful pictures of nature scenes backlit with fluorescent lighting for ceiling and wall mounting in the healthcare environment and are gaining acceptance in the healthcare industry. "Snoworld continues to develop the virtual reality world of snow banks, penguins and igloos to assist in alleviating the stress and pain in burn patients." (Alienware, 2007) Philips Electronics (The Netherlands) created the Ambient Experience, a ceiling and wall mounted computer screen installed in the rooms containing the Philips CT and MRI scanners. Patients choose the theme they would like to watch on these computer screens from Alaskan skylines to Australia's outback. The computer screen projects the nature art with moving objects (hot air balloons, bouncing kangaroos, etc.) similar to the effect of a computer screensaver. LED cove lighting around the perimeter of the room enhances the theme with colors ranging from orange-red for the Australian experience to light lavender for a children's cartoon theme.

Healthcare facilities support this trend by purchasing and installing these products in their facilities. Laughlin Memorial Hospital in Greeneville, Tennessee, recently remodeled their radiology facility. Jesse Taylor, Administrative Director of Radiology at Laughlin, incorporated the Philips Ambient Experience in the CT scanner room creating art work that envelops the room. Patients choose an art theme using a small computer monitor located on the receptionist desk (as shown in *Figure 5*.). When the patient enters the room the chosen theme is displayed using computers projecting down onto screens installed in the ceiling above the patient's bed (as shown in *Figure 6*.). During a tour of the CT facility in July 2007, Mr. Taylor commented, "The patients and staff have appreciated this art. I would like to incorporate it in other rooms."

Figure 5. Receptionist Desk at the Laughlin Memorial Hospital Outpatient Clinic Where Patients View on a Small Computer Monitor the Themes Offered in the Ambient Experience Room.

Figure 6. Philips Ambient Experience in the CT Scanner Room Located in Laughlin Memorial Hospital in Greeneville, Tennessee.

Another dimension of using artificial lighting with art to reduce stress is to design the indirect lighting to follow the biorhythms of natural light. A low level of indirect light behind the art would gradually increase to its highest level of illumination around mid-day and remain constant during the afternoon. The illumination level would gradually start to wane as the afternoon became evening, leaving a lower level of illumination for the night hours. This light would be supplemented with task lighting beside the patient's bed. Direct overhead fluorescent lighting would be available for examination of the patient and cleaning of the room. All lighting would be switched at the door entrance and within reach of the patient lying in bed.

The need for positive distractions in the healthcare environment has been documented through control/treatment research and published in peer reviewed journals. Future research is required to determine the best application for using a positive nature art distraction in the healthcare environment.

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APPENDIXES

APPENDIX A

PHYSICIAN SURVEY INSTRUMENT

Survey of the Pediatric Examination Room
Questions for the Physician

Please check the box next to the answer for each question below.

1. Is this a routine or sick child visit?

☐ Sick ☐ Routine

2. How long did this examination take?

☐ less than 10 minutes ☐ 10-20 minutes
☐ 20-30 minutes ☐ 30-45 minutes ☐ 45-60 minutes

3. Relative to previous exams of this type, would you characterize your exam with this child today as…

☐ very easy ☐ easy ☐ average ☐ difficult ☐ very difficult

APPENDIX B

PARENT/GUARDIAN SURVEY INSTRUMENT

Survey of the Pediatric Examination Room
Questions for the Parent or Legal Guardian

Please answer for each question below.

1. What is the age of your child? ________

2. What is the sex of the child being examined?
☐ Male ☐ Female

3. How did you find the exam room? (Please place an X closest your perception of the room.)

Boring -- Interesting

Warm and Comforting -- Cold and Unfriendly

4. How long did this examination take?

☐ less than 10 minutes ☐ 10-20 minutes
☐ 20-30 minutes ☐ 30-45 minutes ☐ 45-60 minutes

5. If this is the first time your son or daughter has visited the doctor's office for this reason, how would rate his or her anxiety level:

Not At All Anxious -- Highly Anxious

6. If your son or daughter has visited the doctor's office for the same reason today as on previous occasions, how would you compare his or her anxiety levels to those expressed on previous occasions (Please circle the most accurate answer or circle Not/Applicable).

More Anxious About the same Less Anxious Not/Applicable

APPENDIX C

COMMENTS FROM PARENTS/PATIENTS ON THE BACKLIT LIGHT IMAGE

1. One 11 year-old child said “neat” when asked about the light. The 7 year old said he really liked the way the colors changed and asked how much the light cost. He would like to buy one. The mother said she thought the light helped during the examination.
2. The 2 ½ year old child lay on her back and shouted, “Nemo, I love Nemo” and pointed to the light. “Nemo, Mommy, its changing colors.” The mother said the light helped with the examination. It really caught her attention.
3. The child cried during the examination. The doctor came to the door, turned the overhead fluorescent light off and left the LED light on. The child calmed down after 30 seconds. The child did start crying again with the next examination. The child was treated for asthma. The nurse left the overhead fluorescent off and the “nemo” light on during the breathing treatment.
4. Comment from the LPN, “That child is fascinated by that light.” The doctor went in and turned the overhead fluorescent light off for the child the see the “nemo” light. (10 year old child)
5. The mother said, “The last time my 5 year old was in this room the nurse needed to give her a shot. The light was not on. The nurse turned the light on before giving the shot. My daughter was excited by the light. The light did help to distract my daughter’s attention from the shot.”
6. Parent and child noticed the light. Parent remarked she wished she had one in her room. Her 8 year old son (patient) said the light was weird because it changed color and it looked liked the fish moved.

7. I asked the mother if her child noticed the light. She replied, “Yes, that’s the only thing that kept her quiet.”
8. The older child really liked the light. She said, “It’s different.” She did not think it helped her wait for the doctor because she wasn’t scared.”
9. The patient was asked if he liked the light. “Oh yeah,” he said. His mother added, “He wants one in his room!”
10. The parent said the 8 year old child noticed the light immediately and enjoyed the light. The child stared at the light while the survey was taken. When asked, the child said the light made her more comfortable.
11. Family loved the light and showed it to the toddler with each color change. Mother said, “It’s cool”. Father stood and leaned backwards for several minutes to imitate the position of lying on his back to watch the light.
12. The child noticed the light and loved it, but the light did not help him with the examination. The 11 year old brother said he came 1 month earlier with a finger cut. He noticed the light then and really liked it. He said it helped with the examination but wished it was a TV with a movie.
13. A 5 month old child did not notice light until the overhead fluorescent light was turned off. Then she really focused on it.
14. The grandmother used the light to distract the 18 month old child when the grandmother laid the child down on the examination table. The light held the child’s attention for one minute.
15. 1 minute after I entered the room the 2 year old child pointed out the light to me. The mother said her child liked the light and other objects in the room.

16. The 8 year old child noticed the light and greatly enjoyed it. Parent said the child is always anxious about the doctor visits.
17. The older child noticed the light and enjoyed it. The child's 4 month old sister was the patient.
18. The 2 year old child noticed the light. The parent said the light made the room more interesting for the child.
19. The eight year old child noticed the light fixture and enjoyed it.
20. The 4 year old child noticed the light immediately upon entering the room and commented on it.
21. The 2 children noticed the light and enjoyed it (patient was 2 years old). The guardian said it made the room more interesting than normal.
22. The 6 month old noticed the light immediately. The parent said the light had a calming effect and made the room more interesting.
23. The patient was in the room before the light was on. When the light was turned on, the patient and sibling enjoyed the light.
24. 11 year old child really liked the light.
25. Grandmother said the 11 year old child climbed on the bed to see the light. When I left, I turned off the overhead general lighting. "Wow", he said.
26. The 21 month old child did like the light and commented several times on it. The grandmother said the light helped with the examination.
27. The 6 year old child did not notice the light. He kept his eyes down from the doctor during the examination. The parent said he remembered the room from an earlier visit when the nurse had drawn blood from him.

28. 13 month old child did not lie down on the table. The child did not notice light until leaving the room.
29. Child noticed the light. Parents said it helped with the examination.
30. 2 year old child did not pay much attention to the light.
31. The 15 month old patient was in the room before the "nemo" light was turned on. I turned the light on after the survey. The child immediately quieted down while staring at the light.
32. Both children (6 and 7 years old) enjoyed the light fixture and noticed it right away.

VITA

ANNA RAE DUTRO

Education:	Public schools, Natchez, Mississippi
	B.S. Interior Design, East Tennessee State University, Johnson City, Tennessee 2000
	M.S. Engineering Technology, East Tennessee State University, Johnson City, Tennessee 2007
Professional Experience:	Interior Designer with Jackson Interior Design and Furnishing Company, Blountville, Tennessee 2000 to present.
	Registered Interior Designer State of Tennessee #1111
	American Society of Interior Designers member #1243713
Honors and Awards:	Cooper National Lighting and ASID Lighting Competition Honorable Mention 2000
	American Society of Interior Designers Community Service Award State of Tennessee 2006