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Impact of Visual Art on Waiting Behavior in the Emergency Department

By

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Abstract

A pre-post study on the impact of appropriate visual art on the waiting behavior in two prominent emergency departments in Houston, TX, was conducted from September 2009 to March 2010.

An extensive literature review on the existing evidence on stress-reducing visual imagery was conducted to determine the content of the art. This incorporated new insights from the field of neuroscience, as relevant to the emotional experience of waiting in the emergency department (ED). Studies on the ED waiting experience were reviewed, and perceived waiting time was found to be a more compelling determinant of patient experience and satisfaction than actual waiting time. Perceived wait time was also identified as a factor of affective/emotional state. Fear, anxiety, and pain were identified from the literature as three key factors that formed the emotional experience and contributed to the stress of the ED.

A review of both theoretical and experiment-based studies revealed that the "restorative" impact of nature images can be attributed to the affective rather than aesthetic response to stimuli. Neuroscientific studies reiterated that the emotional response is often immediate and can occur before a higher-level cognitive response. Moreover, visual properties such as contour, spatial frequency, and context were identified as key factors influencing emotional processing of visual stimuli by the human brain. These factors are identified for the first time in the context of restorative visual images. Other properties such as familiarity, valence, and arousal, which have been studied in the previous literature, were reinforced. Furthermore, the review established that the broad structural properties of an image and the overall content may be more important than the detail in an image when it comes to emotional response.

To test the impact of visual art on waiting behavior, a set of visual images (nature photographs) was selected based on the existing guidelines for evidence-based art. These images were then evaluated within the context of visual properties identified from the literature review. A visual intervention was designed consisting of wall art and a looped video displayed on plasma screens for two extremely busy ED waiting rooms in Houston (Memorial Hermann Hospital and Ben Taub General Hospital).

Trained observers observed the waiting room for 30 hours (11 nonpeak and 19 peak hours over a period of 3 months) before and after the designed intervention was installed.

Observational data revealed significant reduction in restless behavior and increase in socialization. A decrease in the number of people staring at other people was also found, which has implications for privacy. Trends varied slightly across the two sites (in Ben Taub there was a significant decrease in the front-desk queries, which was not observed in the case of Memorial Hermann). Significant reduction in noise levels was found at both sites as well.

Meaningful conclusions could not be derived from the patient satisfaction, although this data was also collected. Lack of questions that related specifically to the waiting room experience on the patient satisfaction survey, small percentage of the total waiting being spent in the waiting room, and constant changes in the operational variables of the ED process were identified as significant challenges to isolating the impact of the visual intervention on satisfaction scores.

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Executive Summary

Introduction and Aims

In the context of healthcare environments, there is a compelling body of literature on the use of “restorative” visual images that can reduce stress, anxiety, and pain perception (for a comprehensive review of literature see Ulrich (2009) and Hathorn and Nanda (2008). While various theories are in place, little is known about the neural mechanisms that are at work to cause this effect. Also, the evidence has not extended to the particular case of emergency room waiting, which is a uniquely high-stress environment with prolonged wait times (Nanda, et al., In Press).

Wait times have been addressed as one of the most important concerns in emergency department (ED) patients (Holden & Smart, 1999; Derlet & Richards, 2000; Nairn, Whotton, Marshal, Roberts, & Swann, 2004). Research also shows that the perceived wait time is a more compelling indicator of patient satisfaction than actual wait time (Thompson, Yarnold, Williams, & Adams, 1996), and perceived wait time can be effected by emotional or affective states and vice versa (Pruyn & Smidts, 1998). Fear, anxiety, stress, and perception of pain are significant factors in the waiting experience of the ED (Gordon, Sheppard, & Anaf, 2010; Kilpatrick, 1986).

The purpose of this research study was two-fold:

1. To validate and expand the generalizability of the existing evidence base on “restorative” visual images for healthcare through a comprehensive review of the literature with new insights from the neuroscience literature on how visual properties impact emotional states, relevant to the ED.
2. To analyze the effect of still and video nature art, supported by previous evidence, on the waiting behavior of patients and visitors in the ED.

Two prominent Houston hospitals were identified for this study, which are the only two Level 1 trauma centers in the Houston Medical Center: Ben Taub General Hospital and Memorial Hermann Hospital. The Ben Taub General

Hospital (730,000 square feet) is a 650-licensed-bed acute-care facility with more than 26,000 adult and pediatric admissions, 184,000 specialty clinic visits, and over 108,000 emergency patients annually.

The Memorial Hermann Hospital (400,000 square feet) has more than 28,000 admissions per year (including its Children's Hospital and Institute for Rehabilitation and Research), with 419 beds, more than 65,000 outpatient visits, and over 42,000 emergency room visits annually.

Both these hospitals have ED waiting areas that are very distinct in appearance, average patient volume, and patient demographic. Investigating the impact of the use of evidence-based images on the patient experience in these very different sites was an attempt to understand the needs of patients waiting in the emergency room from a broad perspective. In this report, ED1 refers to Ben Taub, and ED2 refers to Memorial Hermann.

Literature Review

A review of the literature on patient experience in the ED showed that perceived waiting time was more important than actual waiting time, and that the affective (emotion-related) component of the waiting experience contributed to the perception. Perceived attractiveness of the waiting environment, which operates mainly through *affect* , can serve as a mood inducer. It can be more effective in impacting patient satisfaction than the perception of the "duration" of wait time, which is more objective and is processed through a *cognitive* route. The literature also established that time-bound distractions (like TV) can inversely impact the perception of wait time since they are episodic and allow a measure of time. Overall, the research converged in the argument that focusing on the affective component of the wait experience was key to improving patient experience. Key components of the affective experience of patients were identified as stress, fear, anxiety, and perception of pain (Nanda, et al., In Press).

Literature on the impact of visual art on health was also revealed. For this study "art" is defined as a visual point of focus that depicts an image (representational or nonrepresentational) in a visual modality. It could be time-bound like video or purely space-bound like framed art and sculptures, with the intent to serve as a positive distraction that is a permanent environmental feature.

A review of the literature revealed that visual art, especially with nature content depicting nonthreatening nature scenes, could significantly reduce stress, perception of pain, and anxiety, based on both physiological and self-report measures. Theoretical frameworks that explained the outcome-based findings were discussed, and a summary of visual features appropriate for healthcare, based on the existing literature, was drafted. This included specific content (such as water, verdant vegetation, people expressing positive emotions), visual properties (such as depth of field, focus, contrast, and clarity), and visual elements (such as prospect, refuge, extent, etc.).

A systematic review of the literature on neuroscience was then conducted using key words for fear, pain, and anxiety and screened for studies that used visual images. Visual properties that elicited a neural response corresponding to relevant emotional states were identified including contours, context, spatial frequency, valence, and arousal. We found that the existing guidelines for appropriate visual art were supported by the neuro-literature. The key insights into image properties were developed into a visual property checklist against which to evaluate the existing guidelines.

Method

A systematic behavioral observation tool was developed to study the behaviors of patients in the waiting room of the two prominent Houston hospitals. The independent variable—art intervention—was designed based on specific criteria developed from the literature review. (Images of the installation are in Appendix A.) The dependent variable—subject behavior—was measured quantitatively by systematic observation. Two types of behaviors were identified: (1) continuous behaviors, such as reading, dozing, or watching TV, that are over a period of time and cannot be counted (noted on a to-scale behavior map), and (2) discrete behaviors, such as getting out of seat, changing seats, stretching, and pacing, that are specific events that can be counted (noted by tally marks as frequency counts).

The final observation instrument consisted of nine frequency counts, four behavior maps, and four noise measurements (attached as Appendix B). A data collection plan was developed based on a uniform sampling of peak and nonpeak times, different times of the day, and different days of the week. Thirty hours of data were collected pre- and post-art intervention in each site (Nanda, et al., In Press).

Observers were trained by the principal investigator on the use of the observation tool. Definitions of each behavior were discussed by the observers prior to the start of study, and a pilot study was conducted to ensure interrater reliability. Interrater reliability was found at 90%. During the pilot, the measuring instruments were also refined to cater to each site's unique layout and challenges.

All the people in the waiting room area were observed, regardless of whether they were patients or visitors and accompanying family members. Staff members with official badges were excluded from the study. Children were noted on the behavior map, but their behavior was not observed.

To analyze the difference in behaviors pre- and post-intervention, while accounting for other related factors, observational variables were grouped into the following categories (Nanda, et al., In Press):

- Distraction activity: These included the activities that people were engaged in using a particular environmental or non-environmental instrument, including talking on cell phone, viewing TV, reading, using laptops, and looking out of the window.
- Non-distraction activity: These included activities where an environmental or instrumental distraction was not being used, such as eating or drinking, looking at other people, talking to other people, dozing, and laying down.
- Restless/anxious behavior: These were behaviors that were hypothesized to be indicative of restlessness and anxiety. These included number of front-desk queries, getting out of seat, changing seat, pacing, fidgeting, stretching, and aggressive behavior (shouting, cussing, shoving, etc.).

Two-way ANOVAs were conducted for each of these three behavioral groups. Bonferroni's post-hoc test was conducted to test for interaction effect between behavior and test condition (pre/post). In addition, t-tests for each subgroup were conducted, with Welch's correction to account for difference in variances. The software used for the analysis was Graphpad Prism V.

Results

Analysis of the summary statistics revealed that the most common behaviors in both sites, before the intervention, included getting of seat, talking, looking at TV, watching other people, talking on cell phones, and dozing. After the intervention, these behaviors were still the most common, but there was a change in how they were ranked. Table 1 shows the top 5 behaviors before and after intervention (with the behaviors with change in rank highlighted). Table 2 shows the ANOVA results for each behavior, with the changed behaviors highlighted (Nanda, et al., In Press).

Table 1 Top Five Observed Behaviors Before and After Art Intervention

PRE-INTERVENTION ED1	POST-INTERVENTION ED1	PRE-INTERVENTION ED2	POST-INTERVENTION ED2
Getting out of seat	Getting out of seat	Getting out of seat	Getting out of seat
People watching	Talking	Talking	Talking
Talking	Getting out of seat	People watching	Using cell phone
Dozing	Dozing	Viewing TV	Dozing
Viewing TV	Viewing TV	Using cell phone	People watching

Table 2 ANOVA Results Comparing Pre- and Postbehavior

BEHAVIOR	ED1	ED2
Out of seat	Significant decrease	Significant decrease
Pacing	Significant decrease	Significant decrease
People watching	Significant decrease	Significant decrease
Talking	Significant increase	No difference
Front-desk queries	Significant decrease	No difference
Fidgeting	No difference	Significant decrease
Noise	Significant decrease	Significant decrease

Discussion

A significant decrease in restless behavior was found in both sites post-intervention (ED1: Out of seat, pacing, front-desk queries, and stretching; ED2: Out of seat, pacing, fidgeting, and stretching). We can argue that the decrease in restlessness came from having a positive distraction, that gave patients something additional to look at while they were in the waiting room. We can also argue that the content of the distraction, serene nature images that followed specific guidelines for selection, were calming in nature. This is further reinforced by the reduction in noise levels found in ED1, even though there was no change in environmental noise sources. This has a strong implication for improving the emotional/affective experience of patients in the waiting area. The reduction of front-desk queries found in ED1 has a significant operational implication—it could result in a decrease in staff time and staff stress. Implications of patient experience on staff stress warrant further investigation.

A significant decrease in people watching, i.e., people staring at other people, was also found post-intervention in both sites. This has a strong implication for privacy. Waiting rooms are often set up as open plans, and as seen in the data, looking at other people is the most common activity. Being looked at can be stressful for someone who is feeling unwell or has a specific deformity. Any reduction in this behavior can be hypothesized to have an impact on patient stress. In ED1 a significant increase in people talking was also found. This implies an increased socialization. Increase in socialization could serve as a means of social support for patients and caregivers.

Finally, there was a significant decrease in the average noise levels in both sites. A difference of around 6 decibels on average was found pre- and post-intervention on both sites. A 6-decibel difference in noise levels is an audible reduction in loudness. While the difference in noise levels can be attributed to the difference in the number of TVs with sound in ED2, this is not the case in ED1, where there were two screens showing regular TV programming at the same volume both pre- and post-intervention.

Previous studies argue that noise levels contribute to patient stress. We argue here that conversely, patient stress contributes to noise levels. Is it possible that a more pleasant environment with carefully researched visual distractions that reduces restlessness in patients and contributes to calm behavior will also contribute to a reduction in ambient noise levels. Anecdotal comments from staff on the floor in ED1 reiterated the findings with the noise meter, with comments on how the ED was quieter. Noise was not the emphasis of this study, but it would be very interesting to investigate this effect further.

Conclusions

This study establishes, through systematic behavioral observation, that providing an evidence-based positive distraction can impact patient experience by reducing restlessness (which can be an indicator of patient anxiety and stress), reducing people watching (which has implications for privacy), and increasing socialization (which could improve social support). Using positive distractions like nature-based video and still art, instead of loud TVs, can also help to bring down the noise level and improve patients' mood, which has implications for patient and staff satisfaction. We can, therefore, conclude that a simple visual intervention, like still and video art, can improve the patient waiting experience in the ED (Nanda, et al., In Press).

Limitations and Future Directions

Due to the high stress and the high traffic in the ED, it was not feasible to interview the patients and visitors directly and ask them about the artwork; a critical qualitative component to the study is therefore missing. Patient satisfaction scores were initially identified as a metric to triangulate the data. Unfortunately due to various operational changes that took place in the hospitals during this time, it was not possible to isolate the impact of the art intervention on satisfaction scores. Moreover, a patient waits in multiple areas of the hospital, and the survey instrument typically asks about the overall waiting experience, including the waiting experience in examination rooms and pre-procedure rooms, which were outside the scope of this study. In a follow-up study, customized survey questions about the main waiting area and multivariate analyses of patient satisfaction data could be attempted.

References

Derlet, R. W., & Richards, J. R. (2000). Overcrowding in the nation's emergency departments: Complex causes and disturbing effects. *Annals of Emergency Medicine, 35*(1), 63–68.

Gordon, J., Sheppard, L. A., & Anaf, S. (2010). The patient experience in the emergency department: A systematic synthesis of qualitative research. *International Emergency Nursing, 18*, 80–88.

Hathorn, K., & Nanda, U. (2008). *A guide to evidence-based art* (a white paper for the Environmental Standards Council). Concord, CA: Center for Health Design.

Holden, D., & Smart, D. (1999). Adding value to the patient experience in emergency medicine: What features of the emergency department visit are most important to patients? *Emergency Medicine, 11*, 3–8.

Kilpatrick, H. (1966). The frightened patient in the emergency room. *The American Journal of Nursing, 66*(5), 1031–1032.

Nairn, S., Whotton, E., Marshal, C., Roberts, M., & Swann, G. (2004). The patient experience in emergency departments: A review of the literature. *Accident and Emergency Nursing, 12*, 159–165.

Nanda, U., Chanaud, C., Nelson, M., Zhu, X., Bajema, R., & Jansen, B. (In Press). Impact of visual art on patient behavior in the emergency department. *Journal of Emergency Medicine.*

Pruyn, A., & Smidts, A. (1998). Effects of waiting on the satisfaction with the service: Beyond objective time measures. *International Journal of Research in Marketing, 15*, 321–334.

Thompson, D. A., Yarnold, P. R., Williams, D. R., & Adams, S. L. (1996). Effects of actual waiting time, percieved waiting time, information delivery and expressive quality on patient satisfaction in the emergency department. *Annals of Emergency Medicine, 28*(6), 657–665.

Ulrich, R. S. (2009). Effects of viewing art on health outcomes. In S. B. Frampton & P. A. Charmel (Eds.), *Putting patients first: Best practices in patient-centered care* (2nd ed., pp. 129–149). San Francisco: Jossey-Bass.

Introduction and Aims

There is a growing body of evidence that argues for the role of nature images in visual art to improve the patient experience of healthcare through reduced stress, anxiety, pain perception, and improved perception of quality of care (Hathorn & Nanda, 2008). Evidence suggests that nature images (through different media) reduce stress (Ulrich, Simons, Losito, Florito, Miles, & Zelson, 1991; Coss, 1990; Ulrich, Lunden, & Eltinge, 1993; Parsons, Tassinary, & Ulrich, 1998; Ulrich, 2009; Heerwagen & Orians, 1990). Research also shows that even short-term visual contact with nature can be restorative. For example, physiological data collected via skin conductance, muscle tension, and pulse transit time from subjects who watched photographic simulations of natural settings showed faster recovery than subjects who viewed simulated urban settings (Ulrich, et al., 1991). While these studies make a strong case that visual art depicting nature scenes can reduce stress, anxiety, and pain perception, there is still confusion on what specific aspects of a nature image, or any visual image for that matter, are restorative and why. With the growing body of literature in the field of neuroscience that can afford precise information about the response of the brain to specific stimuli, it is timely to put the current body of evidence within this context and explore the relevance to the field of healthcare design.

Moreover, only a few studies have made the connection between art, patient experience, and behavior. In a study with pediatric patients, display of different nature-based video conditions via a plasma screen TV screen was seen to improve attention and overall calm behavior in children waiting in dental and cardiac clinics (Pati & Nanda, 2011). In another study with mental health patients, exposure to evidence-based art was found to decrease patient aggression and agitation, which was measured by reduction in PRN (pro re nata) medication (Nanda, Eisen, Zadeh. & Owen, 2011). There is no research that we have been able to identify that quantifiably measures the impact of art on patient and visitor behavior within the context of the emergency department (ED) waiting experience.

The purpose of this research study was two-fold:

1. To validate and expand the generalizability of the existing evidence base on "restorative" visual images for healthcare through a comprehensive review of the literature, with new insights from the neuroscience literature on how visual properties impact emotional states, relevant to the ED.
2. To analyze the effect of still and video nature art, supported by previous evidence, on the waiting behavior of patients and visitors in the ED.

Background and Literature Review

(See Appendixes C, D, and E for matrixes of key articles.)

Emergency departments (ED) in the United States serve a range of functions including managing trauma, responding to disasters, caring for serious illnesses, and providing care for many patients with non-urgent conditions (Wilper, Woolhandler, Lasser, McCormick, Cutrona, Bor, et al., 2008). A 2008 study on ED visits and wait times to see a physician shows that, between 1994 and 2004, total ED visits increased an estimated 18% to 26%, while the number of EDs decreased between 9% and 12%, resulting in a 78% increase in visits per ED between 1995 and 2003 (Wilper, et al., 2008) Even more recent reports by Press Ganey (2010) show a nationwide increase of 4 minutes, since 2009, in the average of total time spent by patients in the emergency room, making the average time a staggering 4 hours and 7 minutes. This adds to an upward increase of 31 minutes since 2002. Findings also show that patients who spend more than 2 hours in the ED show overall less satisfaction than those spending less (Press Ganey, 2010).

Emergency departments face a complex set of challenges unique to the healthcare context, which has resulted in frequent overcrowding of the ED causing extensive wait times and low patient satisfaction. According to Derlet and Richards (2000), overcrowding in ED is caused by a host of factors including increased complexity and acuity of patients coming to the ED; overall increase in patient volume; managed-care problems; lack of beds; intensive therapy in the ED to reduce hospital admissions; delays in service by ancillary services like radiology, lab, etc.; shortage of nursing, administrative staff, and on-call consultants; shortage of space; and language/culture barriers. This results in public safety risk, prolonged pain and suffering, long waits with dissatisfied patients, ambulance diversions, decreased physician productivity, miscommunication, violence in waiting rooms, and compromising the quality of hands-on medical education. Within the cohort of complex factors that are a constant challenge to ED administrators, for patients the determinant of their satisfaction with care is often very simple— it is rooted in their personal experience. A critical component of patients' experience in the ED is their waiting time and waiting experience, which is impacted by the complex set of factors outlined above.

Ed Waiting Experience and Perception of Wait Time

Wait times have been addressed as one of the most important concerns by ED patients (Holden & Smart, 1999; Derlet & Richards, 2000; Nairn, Whotton, Marshal, Roberts, & Swann, 2004). According to Pruyn and Smidts (1998) the adverse effects of waiting can be soothed more effectively by improving the attractiveness of the waiting environment than by shortening the objective waiting time. Objective waiting time influences satisfaction mainly via a cognitive route: mainly through the perceived waiting time in minutes and the judgment whether this time is long or short. Perceived attractiveness of the waiting environment operates mainly through affect, and thus, serves as a mood inducer, which authors have argued is more effective.

Impact of the designed environment on mood is supported by the research by Becker and Douglass (2008) that shows that physical attractiveness of a waiting room impacted anxiety levels and perception of quality of care to a larger degree than actual waiting times. According to Zakay (1989), while the design element of the waiting environment can induce a positive mood influencing the appraisal of the wait (without necessarily influencing perceived duration of the wait), explicit or foreground distracters in the waiting environment can affect the cognitive timer (internal clock) by means of diverting attention from the passage of time itself.

Pruyn and Smidts (1998) propose that the perception of the duration of time is likely to be impacted by more explicit distractions. The literature, however, is lacking in the identification of effective distractions. TV is identified as an "ineffective" distraction. Pruyn and Smidts (1998) found that TV as a source of explicit distraction did not lead to shorter perceived wait times, in fact, people viewing TV perceived the wait time as longer. Also people started viewing TV only after the initial small talk or other self-paced distractions like magazine reading had been exhausted. The literature reviewed makes a strong case for investing in the design environment to improve the affective component of the waiting experience. It also argues for the need for a more dynamic, time-based distraction that could impact the perception of the wait-time duration more than TV. Providing access to information and realistic estimates and updates of wait are operational variables that could impact both the cognitive and affective component of the ED waiting.

Role of Affective States in Wait-Time Perception

Pruyn and Smidts (1998) argue for two components of the appraisal of wait time: (a) a cognitive component that reflects the perception of the time span in terms of long or short and (b) an affective component such as irritation, boredom, stress, etc. They cite Hornik's research (1993) to argue that the experience of a lengthy wait may negatively affect the subject's emotions, but alternatively, the affective state, such as irritation because of waiting, may also influence the time perception. The authors made three points that are at the core of their thesis:

1. Waiting environment is a stronger determinant of service satisfaction than objective waiting time.
2. Waiting environment clearly influences the affective response to the wait; however it does not have an effect on the cognitive response (long/short) judgment of waiting time.
3. Affective response is dependent upon the difference between perceived waiting time and "acceptable" waiting time.

In the case of healthcare environments in general, and emergency waiting in particular, understanding the affective response is critical. In a small-scale observation of the waiting room, Yoon and Sonneveld (2010) found that distrust between the patients and staff of the hospital, the patients' consistent focus on their status, and an uncertainty about the waiting time contributed to patient anxiety. They identified fear, uncertainty and confusion, and annoyance, as factors that contributed to patients' concerns and responses. According to a systematic review of the literature published between 1990 and 2006, qualitative studies addressing the patient experience in the ED identify the emotions of emergency, waiting, and the environment as three of the five factors that influence patient experience (Gordon, Sheppard, & Anaf, 2010). Emotions of emergency, that were identified include anxiety, stress, fear, and pain. Carefully selected visual art can serve as a positive distraction that can impact these emotions.

(Appendix C summarizes findings from some key articles on the waiting experience in the ED.)

Positive Distractions: Health Outcomes and Relevance to ED Waiting

There is a growing body of evidence in place today that argues for the role of nature images in visual art to improve the patient experience of healthcare through reduced stress, anxiety, pain perception, and improved perception of quality of care (Hathorn & Nanda, 2008 in Nanda, et al., In Press). Visual art has been used in various modalities—framed 2-D art, video, large-scale murals, and even virtual reality (Hathorn & Nanda, 2008). A "positive" distraction is an environmental feature that elicits positive feelings and holds attention without taxing or stressing the individual, thereby blocking worrisome thoughts (Ulrich, et al., 1991).

In the medical community, art interventions are often used as positive distractions for patients. Distraction here refers to the direction of attention to a non-toxious event or stimulus in the immediate environment (Fernandez, 1986; Vessey, Carlson, & McGill, 1994). For example, adult patients in a procedure room reported better pain control when exposed to a nature scene with nature sound in the ceiling (Diette, Lechtzin, Haponik, Devrotes, & Rubin, 2003). A nature video (as distraction) resulted in a significant decrease in reported pain intensity, pain quality, and anxiety by burn patients (Miller, Hickman, & Lemasters, 1992). Breast cancer patients reported reduced anxiety during chemotherapy when exposed to virtual reality (VR) intervention displaying underwater scenes (Schneider, Ellis, Coombs, Shonkwiler, & Folsom, 2003).

A similar finding was made when patients were asked to enter a virtual environment by playing video games or wearing a headset (Hoffman, Doctor, Patterson, Carrougher, & Furness, 2000). In a 2002 study at the Hong Kong Polytechnic University, researchers found that, with the use of visual stimuli (soundless nature video), there was a significant increase in pain threshold and pain tolerance (Tse, Ng, Chung, & Wong, 2002). In a 2003 single-case design, researchers found that VR was effective in reducing anxiety and perception of pain from the port-access process of an 8-year-old patient with acute lymphocytic leukemia (Gershon, Zimand, Lemos, Rothbaum, & Hodges, 2003).

In a recent study with a careful control of image conditions, Vincent, Battisto, Grimes, and McCubbin (2010) found that nature images that depicted a balance of prospect and refuge elements significantly reduced the sensory perception of pain. They also found that image depicting hazard (a forest fire) also acted as an effective distraction (reduced blood pressure of patients during a painful procedure), but increased the subjects' mood disturbance. Authors concluded that the hazard image, though an effective distraction acted only temporarily and did not result in positive emotions or feelings immediately afterwards. In this particular case viewing a warm image (of fire) during exposure to a cold stressor (ice water), could also be a confound. It is also possible that a high arousal image is more effective in redistributing attentional resources, but this does not necessarily have a positive and sustaining impact on recovery. Dise-Lewis (1988) explains that distractions are effective because by focusing attention on stimuli other than pain, pain perception becomes a peripheral sensation.

A significant amount of evidence on the impact of visual images (through different media) has focused on stress reduction from viewing nature images (Coss, 1990; Ulrich, 1991; Ulrich, 1993; Parsons, et al., 1998). Stress has a strong physiological component and is manifested in increased heart rate, blood pressure, and skin conductance. In healthcare settings, stress can be caused by fear about impending surgery, lack of information, painful medical procedures, reduced physical capabilities, depersonalization, loss of control, and disruption of social relationships (Ulrich, 2008). Anxiety is a psychological manifestation of stress. Pain, fear, and anxiety, the three emotional states identified in the experience of waiting, all contribute to the overall stress.

Art has also been seen to have stress-reducing effects. According to Evans and Cohen (1987) stress results from a misfit between individual needs and environmental attributes and refers to the process of responding to situations that are demanding, overstimulating, or threatening to well-being. In healthcare settings, stress is an important factor because of its ability to significantly affect medical outcomes through physiological reactions such as increased heart rate and increased blood pressure (Ulrich, 1992). Research shows that even short-term visual contacts can be restorative. Physiological data collected via skin conductance, muscle tension, and pulse transit time from subjects who watched photographic simulations of natural settings showed faster recovery than subjects who viewed simulated urban settings (Ulrich, et al., 1991).

Similar findings were made with heart-rate measurements collected in a dental clinic; patients experienced lower stress on days that a large mural depicting a natural scene was hung on the waiting room wall, versus days when the wall was left blank (Heerwagen & Orians, 1990). In another study patients on gurneys viewing ceiling-mounted scenes of nature and/or water had systolic blood pressure levels 10 to 15 points lower than patients exposed to either aesthetically pleasing "arousing" pictures or a control condition of no picture (Coss, 1990).

Studies have also shown that certain visual images can be inappropriate in clinical settings—a study with heart surgery patients in the intensive care unit of a Swedish hospital compared recovery outcomes across six groups of patients assigned to different picture exposures (nature and abstract images similarly dominated by greens and blues but varying in complexity levels). Patients exposed to a representational, nature image experienced less postoperative anxiety, fewer doses of strong pain medication, but a higher intake of moderate strength pain analgesic, than patients assigned to the five other visual conditions, and exposure to abstract art with rectilinear forms worsened outcomes (Ulrich, et al., 1993).

Most of the studies investigating the impact of positive distractions on health outcomes address short-term exposure—settings that are simulated experiments (such as Ulrich, 1991; Tse, et al., 2002; Vincent, et al., 2010) allow for rigorous investigation but within a constrained time frame. Studies in real-life settings are typically with high-stress areas such as before, during, or after a painful or stressful procedure (e.g., Coss, 1990; Diette, et al., 2003; Ulrich, 1993). Heerwagen and Orians (1990) cited by Ulrich (2009) is one of the few studies that addresses stress outcomes in a waiting environment and found that stress in a dental clinic was appreciably lower on days when a large nature mural was hung on the waiting room wall. No study was found that looked at impact of nature images in waiting areas from an outcomes perspective. However, post-occupancy evaluation research suggests that visual art depicting realistic nature images (based on evidence-based guidelines) were positively perceived by both patients and staff in an oncology outpatient waiting area (Hathorn & Nanda, 2008).

Theoretical Basis and Existing Guidelines

Ulrich (2009) shares two theories that support the research findings on the impact of non-threatening nature scenes on improved physiological and psychological outcomes. The first theory is the evolutionary theory or biophilia theory that holds that millions of years of evolution have left humans to be partly hardwired, or genetically prone, to respond positively to nature settings that fostered well-being and survival for early humans. Appleton's (1975) evolutionary theory outlines specific attributes of landscapes that dictate aesthetic preference as prospect (opportunity/vantage point) and refuge (safety/shelter) that were essential for survival.

The second theory Ulrich identifies is the emotional congruence theory—the notion that emotional states bias perception of environmental stimuli in ways that are congruent or match feelings. Based on these two theories, and much of the research discussed above, certain guidelines for evidence-based art are now in place (Hathorn & Ulrich, 2001; Ulrich & Gilpin, 2003):

Waterscapes

- Calm or nonturbulent water, not stormy conditions.

Landscapes

- Visual depth or openness in immediate foreground.
- Landscapes depicted during warmer seasons when vegetation is verdant and flowers are visible; landscapes conveying bleakness should be avoided.
- Scenes with positive cultural artifacts such as barns and older houses.
- Landscapes with low hills and distant mountains.

Flowers/Gardens

- Flowers that appear healthy and fresh, not wilted or dead.
- Types of flowers that are generally familiar to patients, not novel or strange.
- Garden scenes with some openness in the immediate foreground.

Figurative

- Emotionally positive facial expressions.
- Relationships among people that are friendly, caring, or nurturing.
- Generational and cultural diversity.
- People at leisure in places with prominent nature.

The guidelines outlined above need to be evaluated within the context of other prominent theories that are relevant as well. It is also important to evaluate if there are new insights that can be added to the existing guidelines.

In an earlier work, Ulrich (1983) outlined a psycho-evolutionary framework that argues, based on a review of the literature, that affect precedes cognition (and thereby aesthetic preference). Zajonc (1980) has argued the position of a quick, pre-cognitive, rapid assessment of the environment based on some gross elements of the image that could be insufficient for cognitive judgments but are adequate for an initial approach or avoidance decision, which is at the core of human survival. Zajonc proposes that some properties of visual images elicit an affective response even when they are insufficient for even basic cognitive judgments like recognition.

Based on Zajonc's work Ulrich proposed a theory of preferenda, outlining gross visual properties that could elicit an affective response, as (1) gross configurational or structural aspects of the settings, (2) gross depth properties that require little inference, and (3) general classes of environmental content (e.g, water, vegetation, mountains, etc.). Specific properties outlined by Ulrich based on preference studies include: *Focality* (degree to which a scene contains an area that attracts the observer's attention), *depth of field, ground surface texture* (ground surfaces in the natural environment and the different textures, patterns, and elements that help discern depth in a scene), *deflected vistas* (when a line of sight is deflected or curved, which implies a new landscape information is just beyond the visual bounds), and *lack of threat and tension*.

The theory of a rapid affective evaluation of the environment has been supported by the outcomes studies discussed in the previous section. Research by Korpela, Klemettila, & Hietanen (2002) establishes that rapid evaluation of environmental scenes also modulate people's judgments of human expression (such as joy and anger). Biederman, Mezzanotte, & Rabinowitz (1982) defined five types of relations that characterize a scene:

1. Interposition (objects interrupt their backgrounds)
2. Support (objects tend to rest on supports)
3. Probability (objects tend to be found in some scenes and not others)
4. Position (the typical positions of some objects in some scenes)
5. Size (objects have a limited set of size relations with other objects)

Biederman argues that objects that violate these relations in a scene are generally processed more slowly and with more errors. He also argues for a perceptual system where top-down and bottom-up processes work simultaneously. In a more recent work, Reber, Shwarz, and Winkielman (2004) argue that the more fluently perceivers can process an object, the more positive their aesthetic response, which he states is closely linked to the affective response. Reber proposes that features of stimuli—like amount of information; symmetry; or figure-ground contrast, clarity, and familiarity—influence perceptual fluency as well as preference judgments. In fact, it is the affective response elicited by processing fluency that feeds into judgments of aesthetic appreciation (unless the informational value of the experience) is called into question. The impact of fluency is moderated by expectations and attribution. This notion of processing is more cognitive-based, it relates a basic fluency of image processing to formal attributes that are found in nature scenes, and, more significantly, could be missing in abstract imagery.

There are also theoretical models that argue for the cognitive benefits of nature scenes. Attention restoration theory by Kaplan and Kaplan (1989) argues that viewing nature scenes allows a restoration from the fatigue on people's attentional resources, in other words, natural environments are restorative because they allow relief from mental fatigue. He outlines the components of being away, fascination, extent, and compatibility as features of a natural environment that can be restorative. Kaplan's theory has been applied extensively to tasks involving cognitive functioning such as recall (Berman, Jonides, & Kaplan, 2008). The importance of nature landscapes in improving cognitive function, while interesting, has not been addressed in this report, because of its relatively lower significance for patients in a healthcare setting. This information could be highly pertinent to staff areas in healthcare settings.

In a comparison of Kaplan's and Ulrich's theoretical models, Parsons (1991) proposes a key distinction between the two theories—one focuses on the cognitive and the other on the affective. He makes a compelling argument to take the affective approach stating that "people who are anxious, fearful, angry, etc., though not necessarily fatigued because of sustained periods of directed attention, would be candidates for environmentally induced restoration according to Ulrich's model, but not that of Kaplan and Kaplan" (Parsons, 1991, p.7).

Parsons also proposes that any encounter with an environment engages two affective analyses. The first is immediate, subcortical, based on simple stimulus information that is presented to hard-wired environmental feature detectors and mediated by the amygdala. The amygdala is part of the limbic system that receives information from all sensory modalities and is also connected to various cortical and lower brain centers, including the insula, which enables it to cause rapid changes in the brain and regulate physiological responses such as heart rate or blood pressure (Davidson & Irwin, 1999).

The second affective analysis, according to Parsons, is more deliberate, involves neocortical processing and the comparison of incoming information with stored information (possibly including the communication of the comparison outcome to the amygdale for evaluation), and is hippocampally mediated (the hippocampus is responsible for storing and retrieving conscious memories). Parson's work is one of the earliest works that addresses the need to understand affective responses to environmental stimuli at the level of brain behavior.

(Appendix D summarizes findings from some key articles on the impact of art and positive distractions on health.)

Visual Properties and Neural Response

Although various studies have established a correlation between viewing images and experiencing an emotional or physiological state, it is less clear why certain images are restorative and others are not. Nor is it clear what perceptual mechanisms explain the varied responses to an image and what specific properties of an image invoke what specific emotional responses. Advanced neuro-imaging technology allows for an investigation of the neural underpinnings of human thought and behavior through various techniques, including functional magnetic resonance imaging (fMRI), which measures the blood-oxygen-level dependence (BOLD) signal. Changes in the BOLD levels are an indicator of the neural activity in the brain. Key word searches using "emotional state" (fear/pain/ anxiety), "fMRI," and "visual" were conducted in PubMed (an online database for biomedical literature). Initial responses revealed that although hundreds of articles used visual stimuli to study brain response to emotional states or the neural underpinnings of different emotional states, very few of them addressed the specific properties of the image that could explain the results. By focusing on studies that clearly identified the properties of the visual stimuli the following properties were identified.

(An image showing the key areas of the brain, and its functions, can be found in Appendix F.)

Valence and Arousal

In the psychology literature, visual stimuli for the study of emotional processing are frequently selected from a database of images called the International Affective Picture System (IAPS). Images are categorized primarily along the dimensions of valence (ranging from pleasant or positive to unpleasant or negative), arousal (ranging from calming or soothing to exciting or agitating), and dominance (ranging from large figure to small figure). The image set contains various pictures depicting mutilations, snakes, insects, attack scenes, accidents, contamination, illness, loss, pollution, puppies, babies, and landscape scenes, among others (Lang, Bradley, & Cuthbert, 1997). According to Britton (2006), the IAPS serves as a common emotional probe, depicting emotion-laden scenes to induce affective states.

Physiological measures have routinely been used to evaluate the impact of valence. For example, Vrana, Spence, & Lang (1988) found that the acoustic startle blink reflex varied with the emotional valence (pleasantness-unpleasantness) of picture stimuli, with blinks generally enhanced during viewing of unpleasant stimuli and inhibited during viewing of pleasant stimuli. On the other hand, the amplitude of skin conductance responses has been shown to vary with the rated arousal of pictures stimuli, and the startle blink reflex tends to be largest for pleasant and unpleasant pictures that are highly arousing (Cuthbert, Bradley, & Lang, 1996). The above finding is in line with previous research by Coss (1990) that showed that arousing images of nature increased the stress response in patients. This implies that high arousal in a "pleasant" image can also be stress inducing.

For many visual stimuli studies, it is difficult to dissociate brain circuits involved in the processing of valence and arousal because of the tight connection between stimulus valence and stimuli associated arousal. Anders, Eippert, Weiskopf, and Veit (2008) dissociated stimulus valence and stimulus-related arousal and confirmed that the amygdala was sensitive to stimulus valence even when arousal was controlled for. They found that increased amygdala activity in response to emotional pictures was better explained by valence than by arousal. The amygdala responded to both negative and positive stimuli, and this response did not increase with arousal. In fact, left amygdala activity was decreased in response to arousing compared to nonarousing pictures. In contrast, thalamic and cortical activity increased with arousal suggesting that the amygdala is more sensitive to stimulus valence than level of arousal.

Various studies have established that unpleasant compared with neutral and pleasant pictures can activate the amygdala (Irwin, Davidson, Lowe, Mock, Sorenson, & Turski, 1996; Nitschke, Sarinopoulos, Mackiewicz, Shaefer, & Davidson, 2006; Britton, 2006). This implies that while valence triggers a base-level response in the amygdala that can be linked to the fight-or-flight response, arousal in an image triggers a higher level cortical activity in the brain. Both can be stress-inducing.

Ambiguity

Another key property of visual content is direct or indirect information. Irwin et al. (1996) found that fearful stimuli like pictures of snakes, spiders, or medical procedures (direct threat) can cause the emotion of fear, but so can fearful expressions on other people's faces (indirect threat). Studies of expressive faces and IAPS pictures suggest that similar regions are involved in processing both emotional stimulus types. It is important that seeing an emotional expression on a face gives people only indirect information about the particular context—they are seeing somebody's "reaction" to a stimulus. On the other hand, seeing an emotion-laden scene (like an accident for example) gives people direct information.

Research on facial expressions shows that viewing a fearful face induces fear (Adolphs, Tranel, Hamann, Young, Calder, Phelps, et al., 1999). Additionally, the fear response (measured by amygdala response) increases when fear is detected in members of someone's own culture relative to other cultural groups (Chiao, Iidaka, Gordon, Nogawa, Bar, Aminoff, et al., 2008). There is also research that shows that viewing a fearful face induces more fear than viewing an angry face (Whalen, Shin, McInerney, Fischer, Wright, & Rauch, 2001). Whalen (1998) proposed that fearful faces convey the threat more *ambiguously* than angry faces. Fearful faces signal the presence of threat or danger without identifying the source of that threat, while angry faces signal a more direct and immediate negative consequence.

Whalen argued that since fearful faces require more information about a probable threat than angry faces, they induce greater activation in the amygdala. This hypothesis has been tested in a later neuroimaging study conducted by Whalen et al. (2001). Whalen et al. (2001, p.6) argues that "a system that modulates vigilance will be preferentially activated by a stimulus that requires additional information to be understood." Previous studies that have advocated caution in the use of abstract art in high-stress settings, due to its ambiguous content (Ulrich, 1999; Hathorn & Nanda, 2008; Nanda, et al., 2010) are supported by this theoretical framework.

Context and Familiarity

The presence of context and familiarity in an image helps in the processing of visual information. In a study that linked image property to preference and brain behavior, Bar and Neta (2006) found that real objects (or objects from the real world, photographs) were preferred over meaningless, novel patterns. The preference for real objects could be related to familiarity based on a mere-exposure effect (Zajonc, 2001). This effect is defined as the impact of an increased preference for stimuli that have been seen before, compared with novel stimuli of similar nature. Novelty holds an elevated sense of potential threat, in accordance with previous reports (Blascovich, Mendes, Hunter, & Salomon, 1999).

In an fMRI study that examined the contributions of novelty, valence, and arousal to amygdala activation, Weierich, Wright, Negreira, Dickerson, and Barrett (2010) suggest that novelty is a critical stimulus dimension for amygdala engagement in addition to valence and arousal. In another study, Ongur, Zalesak, Weiss, Ditman, Titone, and Heckers (2005) found significantly greater activation of the right hippocampus when subjects were discriminating previously seen stimuli compared with novel pairs of visual stimuli. This result indicates that the hippocampus also plays an important role in recognizing relationships within previously seen stimulus, but not within novel stimulus. The activation of the hippocampus is relevant to the retrieval of previous memories and the creation of context. The failure to retrieve memories and create a context ties back to the notion of free-floating anxiety discussed previously.

Context is a critical component of familiarity. Visual objects in the environment tend to appear in specific and typical contexts. For example, a blender is expected to be found in a kitchen or on a shelf in an appliance store. Seeing a blender, say on top of a library shelf, will be surprising (Biederman, et al., 1982). To date, only a few studies have addressed the underlying neural mechanisms involved in processing context. Bar and Aminoff (2003) demonstrated the cortical regions that are activated when people recognize visual objects that are highly associated with a certain context (e.g., a hardhat) compared to those are not associated with any unique context in particular (e.g., a fly). Their findings indicate that a part of the cortical region surrounding the hippocampus (the parahippocampal cortex (PHC)) and a region in the retrosplenial cortex (RSC) together comprise a system that mediates contextual processing. Interestingly, the PHC also encompasses the parahippocampal place area, which has been reported to respond selectively to houses and other environmental landmarks, and the RSC has been implicated in the analysis of spatial information. Arguably, the ability to create a clear context could be relevant to orientation in space and time, which could have an indirect impact on emotional states.

In a later study, Bar (2004) quotes the earlier work by McCauley and his colleagues (1980) that establishes that semantic meaning about context is extracted from the input at an early stage, possibly even before perceptual processing is complete. This finding forms the basis of Bar's research where he proposes that the swift extraction of contextual meaning is mediated by global cues conveyed by the low spatial frequencies of an image. The reference to global cues is in line with the work by Zajonc (1980) and the subsequent work by Ulrich (1991) on the theory of preferenda, which is discussed in the theoretical foundation section earlier.

Spatial Frequency

Spatial frequency is defined as the frequency of change in pixel values across an image as a function of distance. The spatial frequency of images can be obtained by the two-dimensional Fourier transform (Bone, Bachor, & Sandeman, 1986). High spatial frequencies represent abrupt spatial changes in the image (such as edges), thus corresponding to configural information and fine detail, whereas low spatial frequencies represent global information about the shape (such as general orientation and proportions). Bar (2004) found that the swift extraction of contextual meaning is mediated by global cues that are conveyed by low spatial frequencies in the image, whereas the detail in the image, conveyed by the high spatial frequencies, are analyzed later. Vuilleumier, Armony, Driver, and Dolan (2003) decomposed fearful face stimuli into their high and low spectral frequency components to explore whether the amygdala and ventral visual cortex have different inputs in the normal human brain. The results indicated that amygdala responses to fearful expressions were greater for low-frequency faces than for high-frequency faces. This further supports Bar's arguments.

Contour

In a preference study comparing responses to everyday objects with curved or sharp edges, Bar and Neta (2006) found that respondents preferred objects with a curved contour compared with comparable objects that had pointed features and a sharp-angled contour. They hypothesized that this partiality stemmed from an inherent perception of potential threat conveyed by sharp visual elements. The later study by these researchers used fMRI to test this hypothesis, and it was found that the amygdala was significantly more active for everyday sharp objects (e.g., a sofa with sharp corners) compared with their curved contour counterparts. This finding provides essential support for the premise that the amygdala activation and subsequent effect on liking is a result of threat conveyed by contour elements.

To provide a direct link between contour type and perception of threat, the authors conducted an additional behavioral experiment by asking explicitly whether these stimuli were perceived as threatening or nonthreatening. Participants found the objects with the sharp elements significantly more threatening than their curved counterparts. The authors concluded that a "preference bias towards a visual object can be induced by low-level perceptual properties, independent of semantic meaning, via visual elements that on some level could be associated with threat. Our brains might be organized to extract these basic contour elements rapidly for deriving an early warning signal in the presence of potential danger" (Bar & Neta, 2007; p. 1). The finding by Bar and Neta at a brain behavior level is in line with previous findings by Ulrich et al. (1993), where an abstract image with rectilinear forms elicited negative outcomes (increased anxiety and pain medication) as compared to an abstract image with curvilinear forms, or having no art at all.

Visual Images for Health: Relevance to Guidelines for Evidence-Based Art

The review of the neuroscientific literature reiterates the pre-cognitive processes at work while people process visual information and the close link between visual properties and emotional response. It also indicates that the broad structural properties of an image and its overall content is as important, if not more, than the detail in an image. This is highly relevant to art selection. The activation of the amygdala in response to valence and arousal and broad structural properties like contour and spatial frequency support the theory about the quick evaluative system that defines people's response to visual images, especially under stress, that has been outlined by previous theories. The role of the amygdala, the hippocampus, and the insula are key, and studies that measure the response in these areas to specific design elements could reveal a lot about the link between emotion and environment.

The research on the impact of facial expressions on emotional processing is relevant from the perspective of image selection, as well as the patient-provider expressions. A facial expression that indicates fear (indicative of a presence of threat) can be as fear-inducing as the source of the threat. Ambiguity in facial expressions can induce fear and anxiety. This finding is particularly relevant to the selection of figurative art in healthcare settings. Facial expressions that are difficult to read or that might seem anxious or fearful should be avoided. Research that establishes that fear responses are larger if the facial expressions belong to someone's own cultural group can be extrapolated to imply that the same would hold for positive emotions. This finding makes an argument for cultural diversity in figurative art, which is recommended in Ulrich's (2009) guidelines. A key insight from studies with facial expressions is that the response to visual stimuli is not related solely to negativity or complexity of the visual stimuli, but also to their ambiguity.

The environmental psychology discussed at the beginning of the literature review does not cover much on facial expressions, but refers instead to the properties of "scenes." However, the insights gleaned from the neuroscience literature review are surprisingly in tandem with this literature. Properties of familiarity, positive valence, low to medium arousal, low ambiguity, and high contextual association are pertinent to issues of content in images and support previous research. The impact of context on memory formation in addition to issues of fear and anxiety is a key insight. The finding that context is rapidly extracted by the low spatial frequencies of an image ties back to the quick evaluative system, as well as the theory of preferenda, which argues that global properties of the image can shape the perception of a viewer and trigger a fight-or-flight response. The rapid extraction of contour information and its impact on the amygdala suggests that issues of content and form must be addressed together.

The research from neuroscience supports the theory of a quick evaluation system for any image, in terms of its impact on a person's well-being (which is a primal response), and which in turn shapes both the emotional belief and the esthetic preference that are formed through the involvement of higher level cortical processes. In this review we have not addressed the issue of esthetic judgment, but a previous work (Nanda, Pati, & McCurry, 2009) addresses the issue of neuroesthetics and the role of emotional processing.

Table 3 lists the visual properties that are outlined in the various theories, and extracted from the review of the literature, with direct or indirect links to emotional processing. These properties include content-based features such as valence, arousal, familiarity, prospect and refuge, and lack of threat, and structural properties such as symmetry, contrast, support, relative position and size, and contours. The last column in Table 3 translates these properties in terms of their relevance to image selection. Some of the properties can be understood as a continuum, such as valence, arousal, complexity, familiarity, and ambiguity. Others are specific elements such as contours, deflected vistas, depth of field, and point of focus.

It is evident from this review of the literature that visual properties, even gross visual properties devoid of semantic meaning, can have an effect on emotional states. It is also evident that many visual properties can only be categorized on a continuum and overlap with each other. So a predictive model of stress reduction based on visual properties is a complex proposition requiring more rigorous studies that isolate the impact of specific variables and more sophisticated statistical modeling. That said, as designers having an understanding of the various parameters and the impact that they can have on perception can be a valuable tool toward decisions about visual art and environments.

Table 3 Summary of Visual Properties Supported by Literature and Relevance to Existing Guidelines

SOURCE/THEORY	VISUAL CONTENT/ PROPERTY	RELEVANCE TO IMAGE SELECTION
Evolutionary theory (Appleton, 1975)	Prospect and refuge	All types of images (waterscapes, landscapes, and gardens) should have a balance of prospect (opportunity/ vantage point) and refuge (safety/shelter) elements.
Attention restoration theory (Kaplan & Kaplan, 1989)	Being away Fascination Extent Compatibility	Images used should allow a viewer to get "away" from immediate surroundings, by having elements of fascination and extent. At the same time they should be compatible to the viewer so he/she can feel comfortable.
Psychoevolutionary theory/theory of preferenda (Ulrich, 1983)	Complexity Focal point Depth of field Surface texture Deflected vista Lack of threat	Images should have an optimum level of complexity (to maintain interest), a focal point, depth of field, and diversity in surface textures to allow processing depth information. Deflected vistas should be used to encourage exploration and provide a promise of more information. Most importantly, there should be no element of threat while incorporating the above.
Properties that elicit positive emotional response from neuroscience literature (Appendix E)	Positive valence Low arousal High familiarity Low ambiguity High context Curved contours	Images selected must have positive content, be unambiguous and familiar, have objects or features that are in context, and be calming rather than arousing. Contours should be curved rather than straight-edged.

From Theory to Practice: Testing the Impact of Art on Waiting Behavior

Based on the synthesis of the literature above, an image bank was created to be used in the design of an art intervention of two ED waiting rooms. Two prominent Houston hospitals were identified for this study, which are the only two Level 1 trauma centers in the Houston Medical Center: Ben Taub General Hospital and Memorial Hermann Hospital.

The Ben Taub Emergency Center (ED1) is the source of 80% of all admissions to the hospital, which provides patients with access to more than 40 medical specialties and houses the only psychiatric emergency center in Houston. This 650-licensed-bed acute-care facility is one of the nation's busiest trauma centers, caring for over 108,000 emergency patients annually. Due to the large volume of patients, with a large percentage of uninsured, Medicare, and Medicaid patients, the time spent in the ED can go up to 10 to 12 hours. This makes the experience of waiting a critical concern. Anecdotal information collected by the hospital shows that the environment is a major determinant in the patients' experience and reported satisfaction. At the time of the study, the only distractions in the ED waiting room were two TV screens that were at a significant distance from most of the waiting patients (and visitors, and a framed period art piece. The waiting area is one large room approximately 40' X 50'. During the period of the study, the total length of stay for patients at Ben Taub ranged from 7.5 to 9.0 hours. (See Appendix G)

The Memorial Hermann Hospital (ED2) has 419 beds and >20,000 inpatient admissions per year. The ED located in the main hospital has more than 40,000 patient visits/admissions per year. In addition, Memorial Hermann has a children's hospital, Children's Memorial Hermann Hospital, with 178 beds and 6,600 inpatient admissions per year, and a rehabilitation hospital, The Institute for Rehabilitation & Research, with 96 beds and 1,200 inpatient admissions per year, in the Texas Medical Center location. From time of arrival to completion of care averages between 3.6 to 4 hours. During the period of the study—October 2009 to March 2010—the wait times from arrival to care averaged between 3.7 to 4.6 hours. (See Appendix G)

In comparison to Ben Taub General Hospital, Memorial Hermann had some positive distractions in place such as an aquarium, plants, and a wall mosaic/mural. The layout of the space is long and linear divided up into small partitions. Each of these pods has a TV. However, this caused some issues with noise as neighboring pods could have their TVs on different channels.

The two ED waiting areas are very distinct in appearance, average patient volume, and patient demographic, which argues for the generalizability of the study findings.

Methodology

The study was designed as a pre-intervention/post-intervention study, with an extensive art install, serving as the intervention. A data collection plan was developed based on a uniform sampling of peak and nonpeak times, different times of the day, and different days of the week (Table 4). Thirty hours of data were collected pre- and post-art intervention in each site (Nanda, et al., In Press).

Table 4 Data Collection Summary

ED1	PRE	POST	ED2	PRE	POST
Nonpeak (6:30 A.M.)	11	10	Nonpeak (6:30 A.M.)	11	10
Peak (12 P.M., 3 P.M., 8 P.M.)	19	20	Peak (12 P.M., 3 P.M., 8 P.M.)	19	20

Observation Instrument

A systematic behavioral observation tool was developed to study the behaviors of patients in the waiting room. The independent variable—art intervention—was designed based on previous literature in the field of evidence-based art and is discussed in the next section. The dependent variable—subject behavior—was measured quantitatively by systematic observation. Two types of behaviors were identified: Continuous behaviors (such as reading, dozing, or watching TV), that are over a period of time and cannot be counted, and discrete behaviors (such as getting out of seat, changing seats, stretching, and pacing), that are specific events that can be counted.

Continuous behaviors were annotated using symbols on a to-scale layout of the emergency waiting area (including furniture) for a period of 5 minutes, every 20 minutes, to obtain the *behavior map* (BM). The following behaviors were annotated:

1. Cell phone usage (listening/talking/texting)

2. Viewing TV

3. Looking at the art intervention (plasma screen or artwork)

4. Reading

5. Talking to other patients/family

6. Looking at other people (people watching)

7. Dozing (in chair)

8. Lying down (on chair or on the floor)

9. Looking out of the window

10. Fidgeting (restless movement such as shaking knees, twiddling fingers, tapping feet, etc.)

11. Eating/drinking

12. Working on a laptop

13. Other activities (not listed)

Discrete behaviors were marked by tally marks each time a behavior occurred in the room, termed as the *frequency count* (FC), on the observation sheet. Each FC was a tally of the number of times the following behaviors occurred in a period of 5 minutes:

1. Enter waiting room

2. Front-desk queries (person asking question at the front desk)

3. Pacing (person moving back and forth)

4. Aggressive behavior (shouting, pushing, shoving, etc.)

5. Out of seat (getting out of seat)

6. Changing seat (changing to new seat)

7. Stretching (extending arms or legs, neck, back, etc.)

8. Exit waiting room

Refer to Appendix B for examples of the observation tool.

The observation instrument consisted of nine frequency counts, four behavior maps, and four noise measurements (N). (See Table 5). Location of where the observers sat is shown in Figure 1. At the end of each BM, the total number of people in the ED was noted.

Table 5 Distribution of Observations in the Period of 65 Minutes

TIME	0 -5 min	6-10 min	11-15 min	16-20 min	21-25 min	26-30 min	31-35 min	36-40 min	41-45 min	46-50 min	51-55 min	56-60 min	61-65 min
OBSERVER ACTIVITY	BM #1 N #1	FC #1	FC #2	FC #3	BM #2 N #2	FC #4	FC #5	FC #6	BM #3 N #3	FC #7	FC #8	FC #9	BM #4 N #4

BM- behavior map; FC- frequency count; N- noise reading

Pilot Study

Observers were trained by the principal investigator on the observation tool. Definitions of each behavior were discussed by the observers prior to start of study, and a pilot study was conducted to ensure interrater reliability. Interrater reliability was found at 90%. During the pilot the measuring instruments were also refined to cater to each site's unique layout and challenges (Nanda, et al., In Press).

Data Collection

All the people in the waiting room area were observed, regardless of whether they were patients or visitors and accompanying family members. Staff members with official badges were excluded from the study. Children were noted on the behavior map, but their behavior was not observed. Observers made a determination on who was a child based on their physical appearance, therefore it is possible that children who looked older were included and adults who look younger were excluded from the study. Observers wore official badges to ensure lack of interference. IRB (internal review board) approval was obtained prior to conducting the study. Informed consent requirement was waived by the IRB since no patient identifiers were being collected.

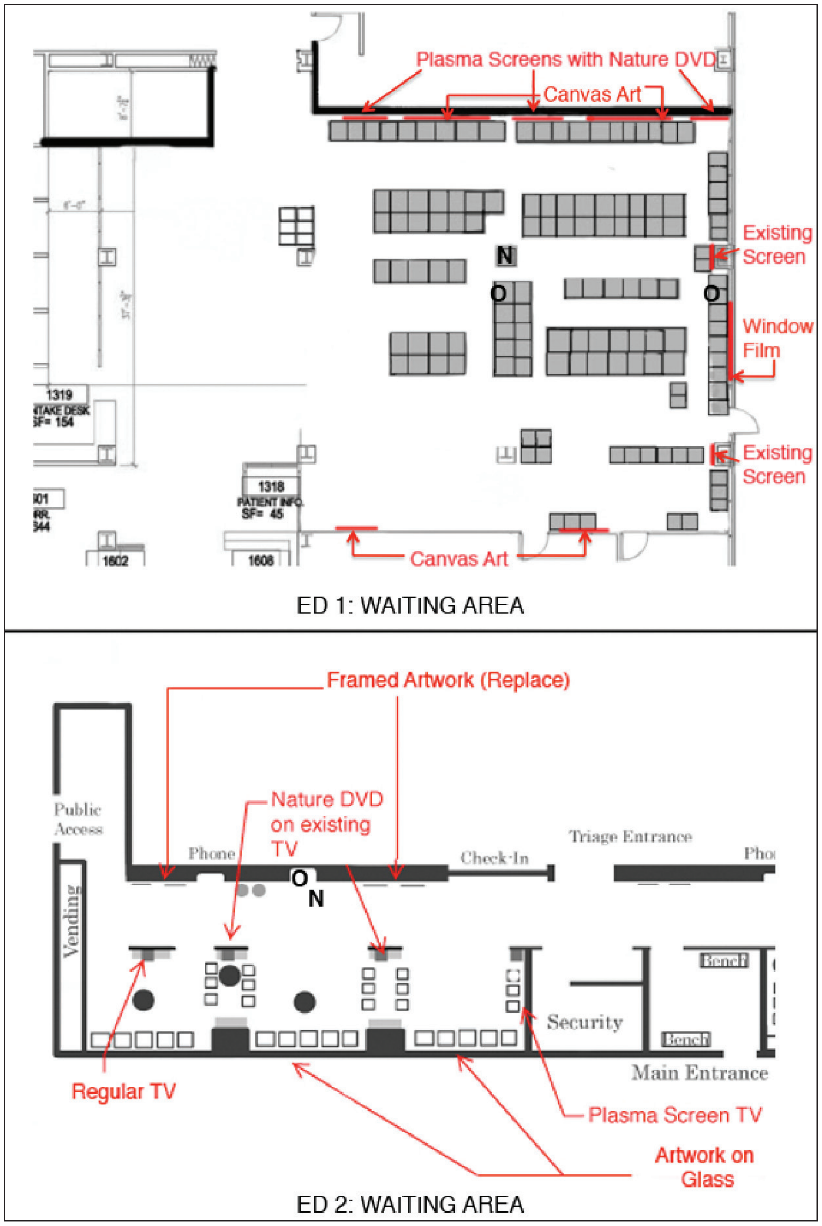
Both observers notated their own qualitative comments on the sheets, which included comments they overheard from patients and staff, operational differences in the ED, traffic patterns they noticed, and unusual behaviors and changes in the environment or layout. The layouts of the two waiting rooms were very distinct. ED1 had a large square open area. (See Figure 1.) Seating in ED2 was fixed, while in ED1 it was a little more flexible (chairs could be added when the volume was high, and the configuration could be modified slightly as needed).

Observers kept record of each change. Since the area was so large, two observers (O) were used for every observation (in ED1, see Figure 1). The waiting room was divided into two sections by the observers prior to the data collection. Two versions of the data collection instrument were created based on activities that could be observed in each position. For example, the observer in the first section would count things like enter/exit of the waiting area, and the person in second section would count the enter/exit of examination rooms. Other behaviors, like getting out of seat or changing seat were counted by both observers for their respective sections. Data from the two sheets were combined during data entry. Observers identified the best seat from those available and annotated it on the map. Sightlines and visibility of patients did not vary due to careful seat selection.

In ED2, given the layout of the waiting room (four bays on one side and four on the other side of the entrance) it was difficult for a single observer to observe both sides of the entrance. A pilot study conducted to test the observation instruments also noted the volume of people on either side. Findings showed that the bays on the right side of the entrance were seldom used and were used more often by staff than patients. The art was installed in the left of the waiting area only. (Shown in Figure 1.)

Noise levels were recorded four times during the course of the observation using a UEI DSM101 sound-level meter for environmental sound measurement. Noise was always measured at the same location on both sites—in the center of the waiting room (N, Figure 1). Observers made notes if there were special circumstances during a reading such as someone yelling or an intercom announcement.

FIGURE 1
ED Layouts and Art Intervention



Art Intervention

The review of the literature revealed that healing outcomes with nature images had been found with both digital and print media. A multimedia visual intervention was designed accordingly. Based on the time perception literature, it was decided a looped video would be used (so that it would not be episodic and lend itself to the measurement of time), which would be displayed on plasma screens.

Four contributing artists, who were identified for their nature photography, donated images. Artists were given a copy of the guidelines for evidence-based art from Ulrich and Gilpin (2003). Contributed photographs were then analyzed for the visual properties identified from the literature (Table 3) by the panel of researchers and shortlisted. A total of 126 images—33 floral, 25 landscape, 38 waterscape—were selected. While the literature on landscapes is extensive, and the presence of water elements is heralded, very little is known about the use of florals, especially images photographed as close-ups, which precludes the fundamental properties of depth of field and prospect and refuge. However, they are mentioned in the initial guidelines by Ulrich and Gilpin (2003). Therefore, florals were used in combination with landscapes and waterscapes in the looped videos, but not in the canvas art that followed the evidence more strictly. Table 6 shows the guidelines followed, sample images used, and the property checklist based upon the literature review to decide on final images.

The selected photographs were sent to a videographer who then formatted a continuous looped video, lasting approximately 20 minutes, that would keep replaying in different sequences (Table 6). For the still art, six images that followed the evidence-based (EB) guidelines closely were selected a printed on canvas to reduce issues of glare. The canvas was wrapped around the frame to give a more windowlike effect.

In ED1, due to the large size of the waiting room, two large canvasses (132"X40"), one medium canvas (54"X36"), and one small canvas (30"X40") were used. Also, three plasma screens were placed (integrated with wood paneling) for the video (based on the proportions). In ED2, only one plasma screen was adequate along with two medium canvasses (60”X40”) and three small canvasses (30”X40”).

Window films were also used at both sites. At ED1, a large garden scene was used and applied to three window panels. In ED2, a continuous cloud pattern was used as a border near the top of the windows to reduce glare issues on screens. Figure 2 shows the post-art installations at the two sites. Appendix A shows the pre-post intervention pictures from the sites.

Table 6 Image Examples

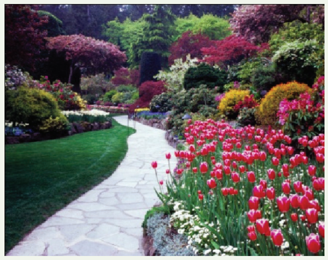
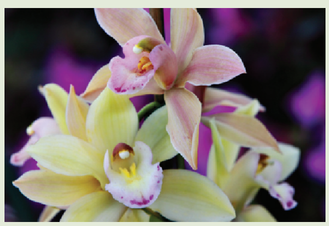
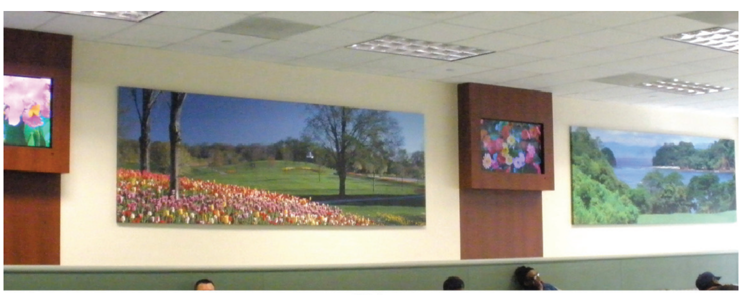
GUIDELINES (from Ulrich & Gilpin, 2003)	IMAGE EXAMPLES	PROPERTY CHECKLIST
Landscapes, waterscapes, and garden scenes • Visual depth or openness in immediate foreground • Warmer seasons, verdant vegetation, flowers in bloom • Positive cultural artifacts such as barns, older houses • Low hills and distant mountains • Calm or nonturbulent water	 © Monte Nagler  © Monte Nagler	Absence of threat and ambiguity Absence of sharp-edged forms/ contours Presence of depth of field, deflected vista, focal point, surface texture Presence of structural and content-based relationships between elements Low arousal Balance of prospect and refuge Medium complexity High contextual association High familiarity
Florals • Flowers that appear healthy and fresh, not wilted or dead • Types of flowers that are generally familiar to patients, not novel or strange	 © Ann Parks	Low arousal Medium complexity High contextual association High familiarity Avoid sharp-edged forms

FIGURE 2
Art Installation in ED1 and ED2. Canvas art by Monte Nagler. Images for video by Monte Nagler, Ann Parks, David Burt, and Bill Robertson



ED 1

ED 2

Analysis

The data from the behavior map and frequency count were entered into an Excel spreadsheet. Behaviors pre- and post-art intervention were totaled for each hour. Each behavior was then represented as a ratio of the total number of people. Summary statistics (histograms) comparing the pre-post behavior ratio were plotted as percentages to see the trends in the behavior (Appendix H1). To analyze the difference in behaviors pre- and post-intervention, while accounting for other related factors, observational variables were grouped into the following categories (Nanda, et al., In Press):

Distraction Activity

These included the activities that people were engaged in using a particular environmental or nonenvironmental instrument, including talking on cell phone, viewing TV, reading, using laptops, and looking out of the window.

Non-distraction Activity

These included activities where an environmental or instrumental distraction was not being used, such as eating/drinking, looking at other people, talking to other people, dozing, and lying down.

Restless/Anxious Behavior

These were behaviors that were hypothesized to be indicative of restlessness and anxiety. These included number of front-desk queries, getting out of seat, changing seat, pacing, fidgeting, stretching, and aggressive behavior (shouting, cursing, shoving, etc.).

Two-way ANOVAs were conducted for each of these three behavioral groups. Bonferroni's posthoc test was conducted to test for interaction effect between behavior and test condition (pre/post). A significant interaction effect was found between the row and column for distraction activity (for ED1), and non-distraction activity and restless behavior (for both sites). Since the interaction between observations (rows) and pre/post (column) was significant, t-tests for each subgroup were conducted, in addition to the Bonferroni's posthoc test during the ANOVA. Due to the difference in variances, Welch's correction was used on the t-tests (correction for unequal variances is not possible in Bonferroni's posthoc test).

Results

Analysis of the summary statistics revealed that the most common behaviors in both sites, before the intervention, included getting of seat, talking, looking at TV, watching other people, talking on cell phone, and dozing (Appendix H1). After the intervention these behaviors were still the most common but there was a change in how they were ranked. Table 1 shows the top 5 behaviors before and after intervention for the two sites. Appendix H2 and H3 include the ANOVA and t-test statistics for all the behaviors. Results from the ANOVA and t-tests are summarized below (Nanda, et al., In Press):

Distraction Activity

ED1: No significant changes in routine distraction activities (cell phone, TV viewing, reading, laptop usage, and looking out of window) were observed pre- and post-intervention.

ED2: Looking out of the window significantly increased and looking at the TV significantly decreased post-intervention. (It should be noted that the total number of TVs showing regular TV programming was lower post-intervention.)

Non-distraction Activity

ED1: There was a significant reduction in people-watching behavior post-intervention and a significant increase in people talking (increased socialization).

ED2: There was a significant reduction in people-watching behavior post-intervention.

Restless/Anxious Behavior

ED1: The ANOVA showed a significant reduction in front-desk queries and out-of-seat behavior post-intervention. T-tests revealed a significant reduction in pacing and stretching, in addition to number of front-desk queries and out-of-seat behavior.

ED2: The ANOVA showed a significant reduction in pacing and out-of-seat behavior post-intervention. In addition, t-tests showed significant reduction in fidgeting and stretching.

Noise

Loudness is defined as “that attribute of auditory sensation in terms of which sounds can be ordered on a scale extending from quiet to loud” (American National Standards Institute, 1973). Loudness, to a great degree, is subjective. Decibel (dB) is the unit of measure for sound pressure level. It is a logarithmic scale developed to express a wide range of quantities on a simple scale (International Electrotechnical Commission, 1989). Sound pressure levels in the ED were measured every 20 minutes, averaged across each observation (four readings), and compared pre- and post-intervention using Mann-Whitney test (non-parametric test that does not assume a Gaussian distribution of data).

Sound pressure levels were found to be significantly lower post-intervention in both ED1 and ED2. Appendix H4 shows the difference in sound pressure levels for the two sites. Although the total number of readings was much lower post-intervention compared to pre-intervention in ED2 (due to unavailability of the noise meter), homogeneity between peak and nonpeak times was maintained. Overall the sound pressure levels were higher in ED1, which is explained by its larger volume of patients. An average reduction of 6 decibels, in sound levels, was found for both sites (Nanda, et al., In Press). A decrease of 6 decibels yields half sound amplitude as the original and can be clearly noticeable to the normal human ear as a significant decrease in apparent loudness (Bies & Hansen, 1997).

Summary of Findings

A pre-post research design was used to study the impact of an art intervention on the behaviors of patients in two busy ED waiting rooms in Houston, TX. The independent variable—art intervention—was based on previous literature in the field of evidence-based art and consisted of nature images in two modalities: A rotating video display and still art printed on canvas and window film. The dependent variable—subject behavior—was measured by systematic observation over a period of 65 minutes, and total of 30 hours of observation before the intervention and 30 hours after the intervention were made, including the measurement of noise levels. A summary of the significant pre- and post-interventions changes as the two ED sites is presented in Table 7 (Nanda, et al., In Press).

Table 7 Summary of Results Pre- and Post- Across ED Sites

BEHAVIOR	ED1	ED2
Out of seat	Significant decrease[1,2]	Significant decrease[1,2]
Pacing	Significant decrease[2]	Significant decrease[1]
People watching	Significant decrease[1,2]	Significant decrease[1,2]
Talking	Significant increase[1]	No difference
Front-desk queries	Significant decrease[1,2]	No difference
Fidgeting	No difference	Significant decrease[2]
Noise	Significant decrease[2]	Significant decrease[2]

1-Bonferroni's post-hoc test; 2- Two-tailed t-test with Welch's correction

A significant decrease in restless behavior was found in both sites post-intervention. In ED1 this was found in the decrease in out-of-seat behavior, pacing, front-desk queries, and stretching. In ED2 this was witnessed in the decrease in out-of-seat behavior, pacing, fidgeting, and stretching. We can argue that the decrease in restlessness came from both a positive distraction, giving patients something additional to look at while they were in the waiting room. We can also argue that the content of the distraction, serene nature images that followed specific guidelines for selection, were calming in nature. This is further reinforced by the reduction in noise levels found in ED1, even though there was no change in environmental noise sources. This has a strong implication for improving the emotional/affective experience of patients in the waiting area. The reduction of front-desk queries found in ED1 has a significant operational implication—it could result in a decrease in staff time and staff stress. Implications of patient experience on staff stress warrant further investigation.

A significant decrease in people watching, meaning people staring at other people, was also found post-intervention in both sites. This has a strong implication for privacy. Waiting rooms are often set up as open plans, and as seen in the data, looking at other people is the most common activity. Being looked at can be stressful for someone who is feeling unwell or has a specific deformity. Any reduction in this behavior can be hypothesized to have an impact on patient stress.

In ED1 a significant increase in people talking was also found. This implies an increased socialization. In ED2 while there was an increase in the means, this was not statistically significant. The absence of this effect can be attributed to layout, which was more intimate and promoted talking, thus the mean talking/person ratio was higher to start with. Increase in socialization can be considered to be an indicator of positive mood. There is a significant amount of literature on the importance of social support in healthcare settings, and this finding has implications from that perspective as well.

In ED1 no significant difference in the distraction activities (cell phone usage, TV viewing, reading) was found. In ED2 a reduction in TV viewing and an increase in looking out of the window was found, which can be explained by the reduction in the number of active TV screens showing regular programming. Whether the reduction in regular TV programming or the introduction of nature-based still and video art is responsible for the behavioral changes can be debated.

Finally, there was a significant decrease in the average noise levels in both sites. A difference of around 6 decibels on average was found pre- and post-intervention on both sites. A 6-decibel difference in noise levels is a significant reduction in loudness. While the difference in noise levels can be attributed to the difference in the number of TVs with sound in ED2, this is not the case in ED1, where there were two screens showing regular TV programming at the same volume both pre- and post-intervention.

Previous studies argue that high noise levels contribute to patient stress. We will argue here that patient stress contributes to noise levels. Is it possible that a more pleasant environment with carefully researched visual distractions that reduces restlessness in patients and contributes to calm behavior will also contribute to a reduction in ambient noise levels. Noise was not the emphasis of this study, but would be very interesting to investigate this effect further. Anecdotal comments from staff on the floor in ED1 reiterated the findings with the noise meter, making comments that the ED was "quieter" even though no active measures for noise control had been taken.

Limitations and Future Directions

Due to the high stress and the high traffic in the ED it was not feasible to interview the patients and visitors directly and ask them about the artwork; a critical qualitative component to the study is therefore missing. Patient satisfaction scores were initially identified as a metric to triangulate the data. Unfortunately due to various operational changes that took place in the hospitals during this time, it was not an appropriate metric for the waiting experience (see note below). Moreover, a patient waits in multiple areas of the hospital, and the survey instrument typically asks about the overall waiting experience including the waiting experience in examination rooms and preprocedure rooms, which were outside the scope of this study. In a follow-up study, customized survey questions about the main waiting area and multivariate analyses of patient satisfaction data could be attempted (Nanda, et al., In Press).

Conclusions and Implications

Studies on the ED waiting experience were reviewed, and perceived waiting time was found to be a more compelling determinant of patient experience and satisfaction than actual waiting time. Perceived wait time was also identified as a factor of affective/emotional state. Fear, anxiety, and pain were identified from the literature as three key factors that formed the emotional experience and contributed to the stress of the ED. A review of both theoretical- and experiment-based studies revealed that the "restorative" impact of nature images can be attributed to the affective rather than aesthetic response to stimuli. Brain behavior associated with these emotional states was identified through a search of articles that provided systematic reviews, and/or, used visual stimuli. Neuroscientific studies reiterated that the emotional response is often immediate and can occur before a higher-level cognitive response. Visual properties such as contour, spatial frequency, and contextual association were identified as key factors influencing emotional processing of visual stimuli by the human brain. These factors are identified for the first time in the context of restorative visual images and warrant additional research. Other properties such as familiarity, valence, and arousal, which have been studied in the previous literature, were reinforced. The review of the neuroscientific literature reiterates the precognitive processes at work while people process visual information and that there is a close link between visual properties and emotional response. It also indicates that the broad structural properties of an image and the overall content is as important, if not more, than the detail in an image. This is highly relevant to art selection.

The insight into appropriate images was translated into a visual art installation at two ED waiting rooms. Findings from a systematic observation of waiting behavior showed that an evidence-based positive distraction can impact *reduce restlessness*, which could be an indicator of patient anxiety and stress; *decrease people watching*, which has privacy implications; and increase socialization, which could impact social support. *Reduction in noise levels* can be achieved through both a reduction in ambient noise levels and as a behavioral outcome of reduced anxiety. This study suggests that including a simple visual art intervention, that is carefully selected based on best available evidence, can not only impact patient (and visitor) behavior, but also the overall healthcare experience.

Note on Patient Satisfaction Scores

ED1: Questions of interest on the patient satisfaction survey included ratings for ED wait time, feelings of if the ED environment was safe, if they were kept informed about ED room wait time, overall quality of care in the ED, and if they would recommend the ED services. An increase on all items (except overall care) was found immediately following the art installation in January. This increase in patient satisfaction was found even though total wait time during that same month increased. However, the increase in the satisfaction scores was not maintained in the following months of February and March.

After speaking with the facility staff we came to realize that much of the patient's waiting time is actually done in many sections of the ED, therefore it may not be an accurate measure for the waiting experience in the main waiting area (where the intervention took place). Also, half-way through the study, ED1 changed its patient satisfaction survey from Press Ganey to NRC Picker, which may have further complicated these findings.

ED2: Although a significant increase in patient satisfaction scores was found for on overall quality of care, likelihood of recommending, and overall "arrival" (composite of all waiting scores), for the first month after the intervention, this effect was not sustained for the following months. It is important to track patient satisfaction scores for a longer period of time and run sophisticated regression models that can take into account the impact of other items, such as perception of staff and physician, and context variables, such as patient volume and actual waiting time.

Also, the scores for waiting time noticed before arrival and helpfulness of first person are higher than other aspects of the waiting experience, which indicates that the main waiting area is (perhaps) a more pleasant experience than the other waiting areas (holding area, bed area, etc.) within the ED. Patient satisfaction scores should be studied after a comprehensive impact on the continuous waiting experience is made.

References

Adolphs, R., Tranel, D., Hamann, S., Young, A. W., Calder, A. J., Phelps, E. A., et al. (1999). Recognition of facial emotion in nine individuals with bilateral amygdala damage. *Neuropsychologia, 37*, 1111–1117.

American National Standards Institute. (1973). *American national psychoacoustical terminology* (S3.20 ed.). New York: American Standards Association.

Anders, S., Eippert, F., Weiskopf, N., & Veit, R. (2008). The human amygdala is sensitive to the valence of pictures and sounds irrespective of arousal: An fMRI study. *SCAN*, *3*, 233–243.

Appleton, J. (1975). The experience of landscape. London: Wiley.

Bar, M. (2004). Visual objects in context. Nature reviews, *Neuroscience*, *5*, 617–629.

Bar, M., & Aminoff, E. (2003). Cortical analysis of visual context. *Neuron*, *38*, 347–358.

Bar, M., & Neta, M. (2006). Humans prefer curved visual objects. *Psychological Science*, *17*, 645–648.

Bar, M., & Neta, M. (2007). Visual elements of subjective preference modulate amygdala activation. *Neuropsychologia*. *45*(10), 2191–2200.

Becker, F., & Douglass, S. (2008). The ecology of the patient visit: Physical attractiveness, waiting time and perceived quality of care. *Journal of Ambulatory Care Management, 31*, 128–141.

Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological Science, 19*, 1207–1212.

Biederman, I., Mezzanotte, R. J., & Rabinowitz, J. C. (1982). Scene perception: Detecting and judging objects undergoing relational violations. *Cognitive Psychology, 14*, 143–177.

Bies, D. A., & Hansen, C. (1997). *Engineering noise control* (2nd ed.). New York: Spon Press.

Blascovich, J., Mendes, W. B., Hunter, S. B., & Salomon, K. (1999). Social "facilitation" as challenge and threat. *Journal of Personality and Social Psychology*, *77*, 68–77.

Bone, D. J., Bachor, H. A., & Sandeman, R. J. (1986). Fringe-pattern analysis using a 2-D Fourier transform. *Applied Optics, 25*(10), 1653.

Britton, J. C. (2006). Facial expressions and complex IAPS pictures: Common and differential networks. *NeuroImag*e, *31*, 906–919.

Chiao, J. Y., Iidaka, T., Gordon, H. L., Nogawa, J., Bar, M., Aminoff, E., et al. (2008). Cultural specificity in amygdala response to fear faces. *Journal of Cognitive Neuroscience, 20*(12), 2167–2174.

Coss, R. (1990). *Picture perception and patient stress: A study of anxiety reduction and postoperative stability.* Unpublished paper, University of California, Davis.

Cuthbert, B. N., Bradley, M. M., & Lang, P. J. (1996). Probing picture perception: Activation and emotion. *Psychophsiology*, *33*, 103–111.

Davidson, R. J., & Irwin, W. (1999). The functional neuroanatomy of emotion and affective style. *Trends in Cognitive Sciences*, *3*, 11–21.

Derlet, R. W., & Richards, J. R. (2000). Overcrowding in the nation's emergency departments: Complex causes and disturbing effects. *Annals of Emergency Medicine, 35*, 63–68.

Diette, G. B., Lechtzin, N., Haponik, E., Devrotes, A., & Rubin, H. R. (2003). Distraction therapy with nature sights and sounds reduces pain during flexible bronchoscopy: A complementary approach to routine analgesia. *Chest, 123*, 941–948.

Dise-Lewis, J. E. (1988). The life events and copy inventory: An assessment of stress in children. *Psychosomatic Medicine*, *50*, 484–499.

Evans, G. W., & Cohen, S. (1987). Environmental stress. In D. Stokels and I. Altman (Eds.), *Handbook of environmental psychology* (pp. 571–670). New York: John Wiley.

Fernandez, E. (1986). A classification system of cognitive coping strategies for pain. *Pain, 26*, 141–151.

Gershon, J., Zimand, E., Lemos, R., Rothbaum, B. O., & Hodges, L. (2003). Use of virtual reality as a distractor for painful procedures in a patient with pediatric cancer: A case study. *Cyberpsychology and Behavior, 6*, 657–661.

Gordon, J., Sheppard, L. A., & Anaf, S. (2010). The patient experience in the emergency department: A systematic synthesis of qualitative research. *International Emergency Nursing, 18*, 80–88.

Hathorn, K., & Nanda, U. (2008). *A guide to evidence-based art* (a white paper for the Environmental Standards Council). Concord, CA: Center for Health Design.

Hathorn, K., & Ulrich, R. S. (2001). The therapeutic art program of Northwestern Memorial Hospital. In *Creating environments that heal: Proceedings of the Symposium on Healthcare Design* [CD-ROM]: Imark Communications in association with Center for Health Design.

Heerwagen, J., & Orians, G. (1990). The psychological aspects of windows and window design. *EDRA, 21*, 269–280.

Hoffman, H. G., Doctor, J. N., Patterson, D. R., Carrougher, G. J., & Furness, T. A., III. (2000). Virtual reality as an adjunctive pain control during burn wound care in adolescent patients. *Pain, 85*, 305–309.

Holden, D., & Smart, D. (1999). Adding value to the patient experience in emergency medicine: What features of the emergency department visit are most important to patients? *Emergency Medicine*, *11*, 3–8.

Hornik, J. (1993). The role of affect in consumers' temporal judgments. *Psychology and Marketing, 10*, 239–255.

International Electrotechnical Commission. (1989). International Standard CEI-IEC 27-3 Letter symbols to be used in electrical technology Part 3: Logarithmic quantities and units. Geneva, Switzerland.

Irwin, W., Davidson, R. J., Lowe, M. J., Mock, B. J., Sorenson, J. A., & Turski, P. A. (1996). Human amygdala activation detected with echoplanar functional magnetic resonance imaging. *NeuroReport*, *7*, 1765–1769.

Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. New York: Cambridge University Press.

Korpela, K. M., Klemettila, T., & Hietanen, J. K. (2002). Evidence for rapid affective evaluation of environmental scenes. *Environment and Behavior*, *34*, 634–650.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). *International Affective Picture System (IAPS): Technical manual and affective ratings*. Gainesville, FL: NIMH Center for the Study of Emotion and Attention, University of Florida.

McCauley, C., Parmelee, C. M., Sperber, R. D., & Carr, T. H. (1980). Early extraction of meaning from pictures and its relation to conscious identification. *Journal of Experimental Psychology: Human Perception and Performance, 6*(2), 265–276.

Miller, A. C., Hickman, L. C., & Lemasters, G. K. (1992). A distraction technique for control of burn pain. *Journal of Burn Care and Rehabilitation*, *13*, 576–80

Nairn, S., Whotton, E., Marshal, C., Roberts, M., & Swann, G. (2004). The patient experience in emergency departments: A review of the literature. *Accident and Emergency Nursing, 12*, 159–165.

Nanda, U. Eisen, S., Zadeh, R., & Owen, D. (2011). Effect of visual art on patient anxiety and agitation in a mental health facility and implications for the business case. *Journal of Psychiatric and Mental Health Nursing*, 18(5), 386-393.

Nanda, U., Pati, D., & McCurry, K. (2009). Neuroaesthetics and healthcare design. *Health Environment Research and Design Journal, 2*(2), 116–133.

Nanda, U., Chanaud, C., Nelson, M., Zhu, X., Bajema, R., & Jansen, B. (In Press). Impact of visual art on patient behavior in the emergency department. *Journal of Emergency Medicine.*

Nitschke, J. B., Sarinopoulos, I., Mackiewicz, K. L., Schaefer, H. S., & Davidson, R. J. (2006). Functional neuroanatomy of aversion and its anticipation. *NeuroImage, 29*, 106–116.

Ongur, D., Zalesak, M., Weiss, A. P., Ditman, T., Titone, D., & Heckers, S. (2005). Hippocampal activation during processing of previously seen visual stimulus pairs. *Psychiatry Research, 139*(3), 191–198.

Parsons, R. (1991). The potential influence of environmental perception on human health. *Journal of Environmental Psychology*, *11*, 1–3.

Parsons, R., Tassinary, L. G., & Ulrich, R. S. (1998). The view from the road: Implications for stress recovery and immunization. *Journal of environmental psychology*, *18*, 113–140.

Pati, D., & Nanda, U. (2011). Influence of Positive Distractions on Children's in Two Clinic Waiting Areas. *Health Environments Research & Design Journal,* 4(3): 124-140.

Press Ganey. (2010). *Pulse report: 2010 emergency department*. South Bend, IN: Press Ganey Associates, Inc.

Pruyn, A., & Smidts, A. (1998). Effects of waiting on the satisfaction with the service: Beyond objective time measures. *International Journal of Research in Marketing, 15*, 321–334.

Reber, R., Schwarz, N., & Winkielman, P. (2004). Processing fluency and aesthetic pleasure: Is beauty in the perceiver's processing experience. *Personality and Social Psychology Review, 8*, 364–382.

Schneider, S. M., Ellis, M., Coombs, W. T., Shonkwiler, E. L., & Folsom, L. C. (2003). Virtual reality intervention for older women with breast cancer. *Cyberpsychology, Behavior and Social Networking, 6*(3), 301–307.

Tse, M. M., Ng, J. K., Chung, J. W., & Wong, T. K. (2002). The effect of visual stimuli on pain threshold and tolerance. *Journal of Clinical Nursing, 11*, 462–469.

Ulrich, R. S. (1983). Aesthetic and affective response to natural environment. In I. Altman & J. Wohlwill (Eds.), *Human behavior and environment: Behavior and natural environment* (pp. 85–125). New York: Plenum.

Ulrich, R. S. (1991). Effects of interior design on wellness: Theory and recent scientific research. *Journal of Health Care Interior Design, 3*, 97–109.

Ulrich, R. S. (1992). How design impacts wellness. *The Healthcare Forum Journal*, *35*, 20–25.

Ulrich, R. S. (1993). Biophilia, biophobia, and natural landscapes. In S. R. Kellert & E. O. Wilson (Eds.) *The Biophilia Hypothesis* (pp.74-137). Washington, DC: Island Press/Shearwater.

Ulrich, R. S. (1999). Effects of gardens on health outcomes: Theory and research. In C. C. Marcus & M. Barnes (Eds.), *Healing gardens: Therapeutic benefits and design recommendations* (pp. 27-86). New York: Wiley.

Ulrich, R. S. (2008). Biophillic theory and research for health design. In S. Kellert, J. Heerwagen, & M. Mador (Eds.), *Biophillic design: Theory, science, and practice* (pp. 87-106). New York: Wiley.

Ulrich, R. S. (2009). Effects of viewing art on health outcomes. In S.B. Frampton & P.A. Charmel (Eds.), *Putting patients first: Best practices in patient-centered care* (2nd ed., pp. 129-149). San Francisco: Jossey-Bass.

Ulrich, R. S., & Gilpin, L. (2003). Healing arts: Nutrition for the soul. In S. B. Frampton, L. Gilpin, & P. A. Charmel (Eds.), *Putting patients first: Designing and practicing patient-centered care* (pp. 117-146). San Francisco: John Wiley & Sons.

Ulrich, R. S., Lunden, O., & Eltinge, J. L. (1993). *Effects of exposure to nature and abstract pictures on patients recovering from heart surgery*. Thirty-third meeting of the Society of Psychophysiological Research, Rottach-Egern, Germany.

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*, 201–230.

Vessey, J. A., Carlson, K. L., & McGill, J. (1994). Use of distraction with children during an acute pain experience. *Nursing Research, 43*(6), 369–372.

Vincent, E., Battisto, D., Grimes, L., & McCubbin, J. (2010). The effects of nature images on pain in a simulated hospital patient room. *Health Environment Research and Design Journal, 3*(3), 42–55.

Vrana, S. R., Spence, E. L., & Lang, P. J. (1998). The startle probe response: A new measure of emotion? *Journal of Abnormal Psychology*, *97*, 487–491.

Vuilleumier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2003). Distinct spatial frequency sensitivities for processing faces and emotional expressions. *Nature Neuroscience*, *6*, 624–631.

Weierich, M. R., Wright, C. I., Negreira, A., Dickerson, B. C., & Barrett, L. F. (2010). Novelty as a dimension in the affective brain. *Neuroimage, 49*(3), 2871–2878.

Whalen, P. J. (1998). Fear, vigilance, and ambiguity: Initial neuroimaging studies of the human amygdala. *Current Directions in Psychological Science*, *7*, 177–188.

Whalen, P. J., Shin, L. M., McInerney, S. C., Fischer, H., Wright, C. I., & Rauch, S. L. (2001). A functional MRI study of human amygdala responses to facial expressions of fear versus anger. *Emotion*, *1*, 70–83.

Wilper, A., Woolhandler, S., Lasser, K., McCormick, D., Cutrona, S., Bor, D., et al. (2008). Waits to see an emergency department physician: U.S. trends and predictors, 1997–2004. *Health Affairs, 27*, 84–95.

Yoon, J., & Sonneveld, M. (2010). Anxiety of patients in the waiting room of the emergency department. *Proceedings of the Fourth International Conference on Tangible, Embedded and Embodied Interaction* (pp. 279–286). Cambridge, MA: Association for Computing Machinery.

Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist, 35*(2), 151–175.

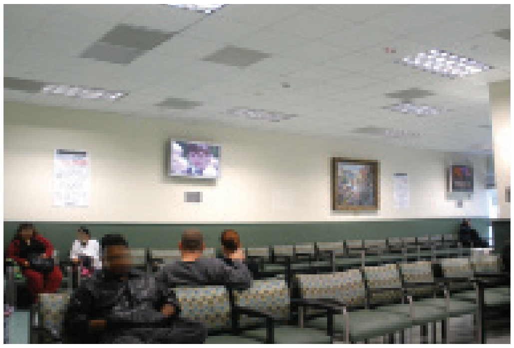
Zajonc, R. B. (2001). Mere exposure: A gateway to the subliminal. *Current Directions in Psychological Science*, *10*, 224–228.

Zakay. D. (1989). An integrated model of time estimation. In I. Levein & D, Zakay (Eds.), *Time and human cognition: A life span perspective* (pp. 365–397). North-Holland, Amsterdam: Elsevier.

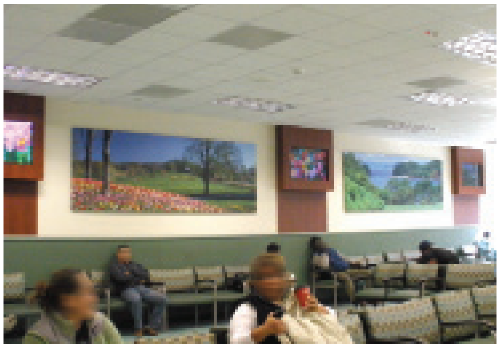
Appendix A: Pre-Post Installation Pictures

Ben Taub

Main Wall: Still Canvas Art and Plasma Screen Distraction



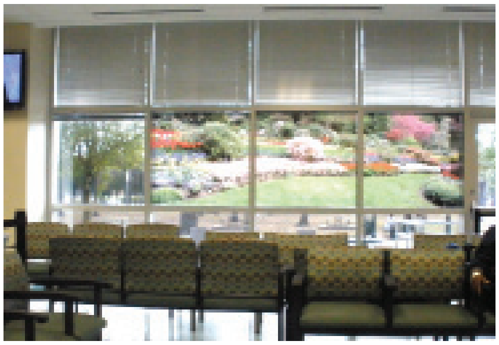
BEFORE



AFTER

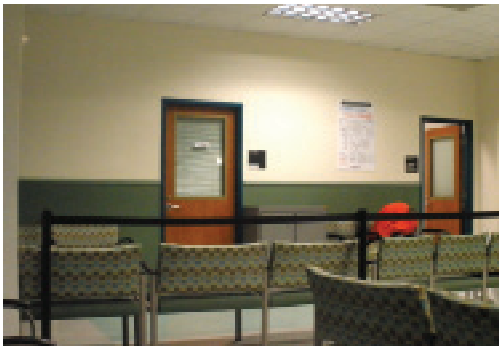
Window Film

BEFORE



AFTER

Still Art on Canvas



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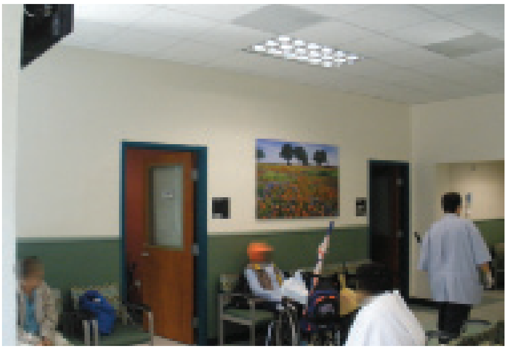


AFTER

Memorial Hermann

Plasma Distraction and Window Film

BEFORE

AFTER

Still Artwork

BEFORE

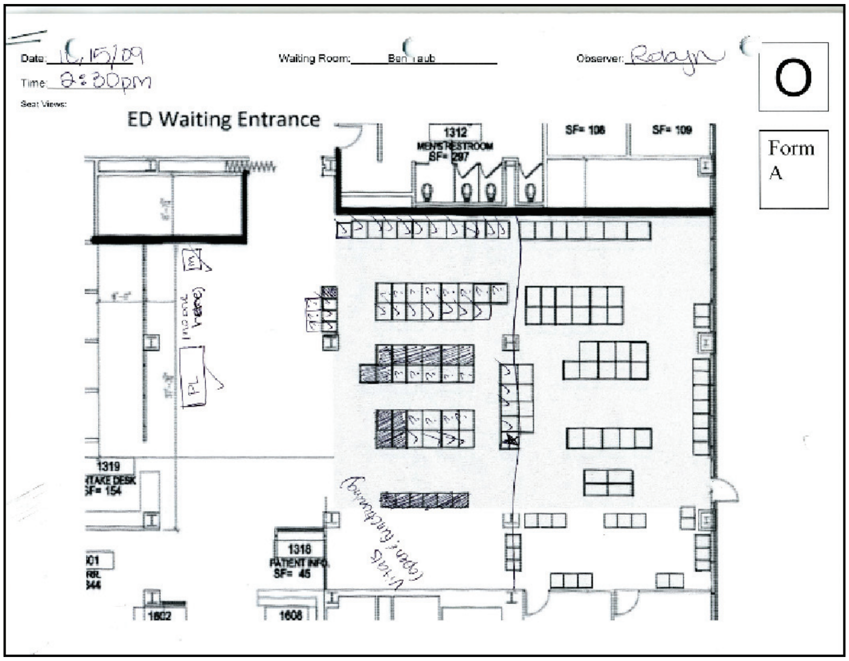
AFTER

BEFORE

AFTER

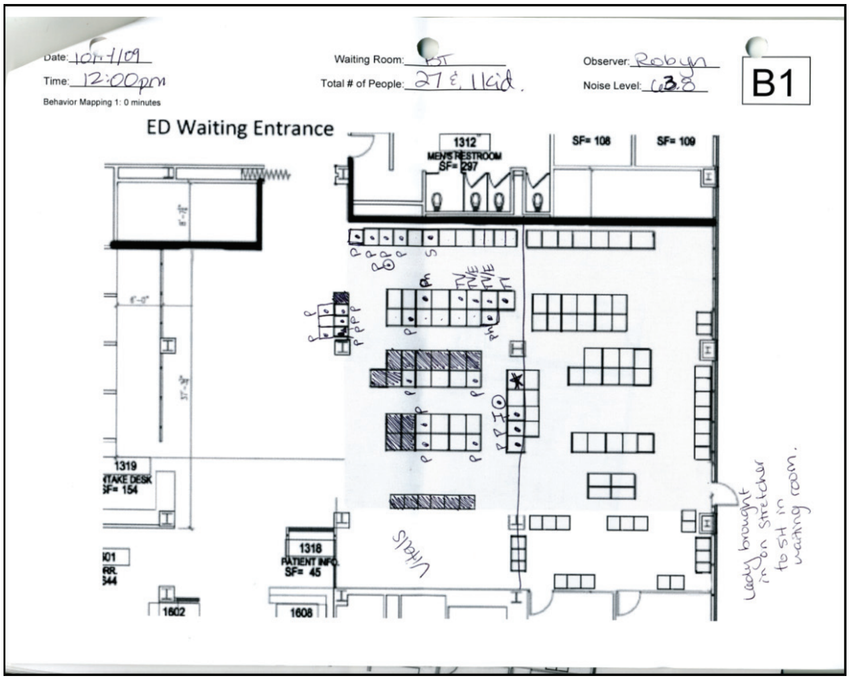
Appendix B: Sample Observation Instrument and Coding Descriptions

Sheet 1: Seat Layout and Observer Placement/Vantage Points



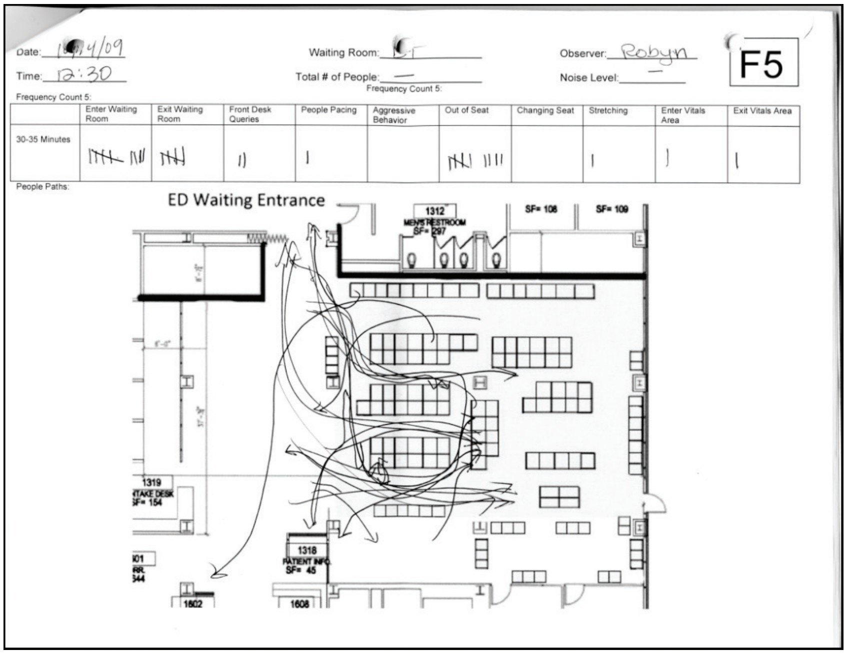
NOTATION	DESCRIPTION
✓	Seat is fully visible.
?	Seat is partially visible, facing away from observer (so cannot see faces of subjects).
✘	Seat is not visible at all.

Behavior Map Example



BEHAVIOR/PERSON	NOTATION	DESCRIPTION
Cell Phone (phone/text)	Ph	Use of cell phone (listening or talking)
Viewing TV	TV	Looking at the TV monitor
Viewing positive distraction	PD	Looking at the art intervention (plasma screen or artwork)
Magazines/reading	R	Reading magazines
Talking to other patients/family	T	Being in a discussion with other people
People watching	P	Looking or staring at other people
Dozing (in chair)	D	Eyes closed while in an upright position
Lying down	L	Lying down on the chairs
Looking out of window	W	Looking out of the window
Fidgeting	F	Continuous restless movement such as shaking knees, twiddling fingers, etc.
Eating/drinking	E	Eating or drinking any food or beverage, also gum chewing
Laptop/computer	C	Using a laptop
Other activities	O	Any activity not listed above, other than simply sitting
Adult (standing)		Dot
Adult (sitting)		Square with dot
Adult hold baby/child	▲	Triangle within a circle
Child/baby	▲	Triangle
Person in wheelchair		Dot within a circle

Behavior Map Example



BEHAVIOR (COUNT)	DESCRIPTION
Enter/exit waiting room	Anyone entering or leaving the specified waiting area
Front-desk queries	Person asking question at front desk
People pacing	Person standing up, moving back and forth
Aggressive behaviors	Shouting, pushing, shoving, cursing, etc.
Out of seat	Getting up out of seat
Changing seat	Getting out of current seat and moving to a new one
Stretching	Extending arms or legs, neck, back, etc.

Appendix C: Articles on the Ed Waiting Experience

Citation	Type of Study	Method	Findings	Visual Property/ Emotional State	Implication
Kilpatrick, H. (1966). The Frightened Patient in the Emergency Room. *American Journal of Nursing, 66*(5), 1031-1032.	Opinion paper	Personal narrative	Confidence and caring from nurse help deal with emotion and physical suffering of ED patients.	Fear, anxiety, stress	Nurse satisfaction is key to patient satisfaction; environments must cater to staff needs.
Boudreaux, E., & O'Hea, E. (2004). Patient Satisfaction in the Emergency Department: A Review of the Literature and Implications for Practice. *Journal of Emergency Medicine, 26*(1), 13-26.	Systematic review of literature	Search of three electronic databases: MEDLINE, CINAHL, and PSYCH-INFO; Key words: patient satisfaction, customer satisfaction, emergency department, emergency medicine.	Satisfaction with interpersonal interactions with ED physicians and nurses is the strongest predictor of patient satisfaction scores. Perceived technical skills and perceived wait times are of secondary importance.	NA	Interpersonal relationships depend on the staff satisfaction, that should be taken into account.
Wilper, A., Woolhandler, S., Lasser, K., McCormick, D., Cutrona, S., Bor, D., et al. (2008). Waits To See An Emergency Department Physician: U.S. Trends and Predictors, 1997-2004. *Health Affairs, 27*(2), 84-95.	Retrospective analysis of survey data	Analysis of the National Hospital Ambulatory Medical Care Survey data from 1997-200 and 2003-2004 for U.S. ED and hospital outpatient departments.	Wait time for patients with acute myocardial infarction increased 11.2% per year compared to the average wait time increase of 4.1% per year. However, proportion of ED visits that were emergent decreased over time, supporting the view that compromised access to primary care is increasing ED use.	NA	The increasing number of non-urgent patients means more time in the waiting room.

Citation	Type of Study	Method	Findings	Visual Property/ Emotional State	Implication
Derlet, R. W., & Richards, J. R. (2000). Overcrowding in the Nation's Emergency Departments: Complex Causes and Disturbing Effects. *Annals of Emergency Medicine, 35*(1), 63-68.	Opinion paper	NA	Overcrowding in ED is caused by increased complexity and acuity of patients presenting to the ED; overall increase in patient volume; managed-care problems; lack of beds; intensive therapy in the ED to reduce hospital admissions; delays in service by ancillary services like radiology, lab, etc.; shortage of nursing, administrative staff, and on-call consultants; shortage of space and language/ culture barriers; all of which contribute, among other factors, to long and painful waiting times.	NA	Increased demands on existing ED resources implies more time waiting.
Zakay, D. (1989). Subjective Time and Attentional Resource Allocation: An Integrated Model of Time Estimation. In I. Levin & D. Zakay (Eds.), *Time and Human Cognition* (pp. 365-397). North-Holland: Elsevier Science Publishers.	Theory	Review of literature with findings from four experimental studies to develop a theoretical model for how humans estimate time.	There is a distinction between prospective and retrospective estimates of time. Wait time perception depends on allocation of attention between temporal and nontemporal processor. The environment can induce a positive “mood” without influencing the duration of time. Foreground distractions in the environment can affect the cognitive timer (internal clock) by diverting attention from the passage of time.	N/A	Environmental features may address perception through mood or emotional state. However, time-based distractions might be more suitable for improving assessment of duration.

Citation	Type of Study	Method	Findings	Visual Property/ Emotional State	Implication
Holden, D., & Smart, D. (1999). Adding Value to the Patient Experience in Emergency Medicine: What features of the emergency department visit are most important to patients?. *Emergency Medicine, 11*, 3-8.	Survey	Five hundred and fifty-five emergency patients, and 60 ED medical and nursing staff were surveyed, asking each to rank 10 features of the ED visit in order of importance to patients. Analysis was by Chi-squared test and Mann -Whitney U-test to compare survey responses between the patient and staff populations.	Patients ranked waiting time as most important, followed by symptom relief, a caring and concerned attitude from staff, and diagnosis of the presenting complaint. Staff identified the same four factors as important but ranked waiting time fourth.	NA	Given the importance of waiting time and the need to sense caring and concern from the staff, the environment should be one that promotes this sense of caring and is restorative to both staff and patients.
Nairn, S., Whotton, E., Marshal, C., Roberts, M., & Swann, G. (2004). The patient experience in emergency departments: a review of the literature. *Accident and Emergency Nursing, 12,* 159-165.	Systematic review of literature	Used CINAHL and MEDLINE databases using the following search terms: patient experience, patient satisfaction, emergency services, and emergency care.	Six themes were covered: (1) Waiting times (biggest indicator of patient satisfaction, shorter wait times better experience), (2) communication (the more communication the better the experience), (3) cultural aspects (nurses need to accommodate older people's needs as well as minorities), (4) pain (Don't let patient leave without pain being manageable.), (5) ED environment (quality of care needs to be high), (6) dilemmas (hard to access full concept of the patient experience due to limited scope of patient satisfaction surveys).	N/A	Waiting times impact patient satisfaction scores, however, patient satisfaction surveys are limited and cannot provide full details about the quality of waiting. Pain management is a key component of ED waiting.

Citation	Type of Study	Method	Findings	Visual Property/ Emotional State	Implication
Thompson, D. A., Yarnold, P. R., Williams, D. R., & Adams, S. L. (1996). Effects of Actual Waiting Time, Percieved Waiting Time, Information Delivery and Expressive Quality on Patient Satisfaction in the Emergency Department. *Annals of Emergency Medicine, 28*(6), 657-665.	Survey	Over a 12-month study period, a telephone survey was administered to a random sample of patients who had presented to a suburban community hospital ED during the preceding 2 to 4 weeks. Respondents were asked several questions concerning wait times (i.e., time from triage until examination by the emergency room physcican and time from triage until discharge from the ED), information delivery (i.e., explanations of procedures and delays), expressive quality (i.e., courteousness, friendliness), and overall patient satisfaction.	It is not the actual wait time, but the perception of wait time that is the determining factor in patient satisfaction. Perceptions regarding waiting time, information delivery, and expressive quality predict overall patient satsifaction. However actual waiting times do not. Providing information projecting expressive quality and managing waiting time perceptions and expectations may be a more effective strategy to achieve improved patient satisfaction in the ED than decreasing actual waiting time.	NA	The environment in general, and art in particular can help in the "projecting expressive quality" that could impact the perception of waiting. Operational initiatives such as providing information and managing wait time perceptions and expectations could be supported by the overall expressive quality facilitated by the environment.
Thompson, D. A., Yarnold, P. R., Adams, S. L., & Spacone, A. B. (1996). How accurate are waiting time perceptions of patients in the emergency department? Annals of Emergency Medicine, 28(6), 652-656.	Mixed methods (survey and retrospective)	A questionnaire was administered by phone to a random sample of 776 patients (or parents or responsible caretakers, if appropriate) who had been treated within the previous 2 to 4 weeks in the ED of a suburban hospital. Respondents were asked their perceptions of two particular time frames: (1)time elapsed from triage until initial examination by the ED physician and (2)time elapsed from triage until departure from the ED (total waiting time). Actual times were extracted from a computerized database. Time frames were divided into discrete periods for comparison. The correspondence between actual and perceived times was assessed by optimal data analysis.	Patients are not very accurate in their estimation of actual waiting times. Although fewer than 1/4 of the respondents overestimated the total wait time spent in the ED, almost half the respondents overestimated the percieved wait time.	N/A	The wait time to see a physician, is the key component of the waiting experience. Time waiting for physician is not necessarily in the waiting room, this needs to be taken into account while designing the waiting experience.

Citation	Type of Study	Method	Findings	Visual Property/ Emotional State	Implication
Gordon, J., Sheppard, L. A., & Anaf, S. (2010). The patient experience in the emergency department: A systematic synthesis of qualitative research. *International Journal of Emergency Nursing, 18,* 80-88.	Systematic review of literature	Review of qualitative literature published between 1996 and 2006 exploring the patient experience within the emergency department. Databases: CINAHL, MEDLINE, Scopus, PubMED, AMED.	Overarching categories identified after the review of literature: emotional impact of emergency, staff-patient interactions, waiting, family in the ED, and environment.	Stress, fear, anxiety, pain: emotional context of perceived emergency situation.	There is a significant emotional impact of a perceived emergency situation that is revealed more in the qualitative than quantitative data on the waiting experience. This is a significant factor on the perception and experience of waiting.
Pruyn, A., & Smidts, A. (1998). Effects of waiting on the satisfaction with the service: Beyond objective time measures. International *Journal of Research in Marketing, 15,* 321-334.	Mixed methods (survey and observation)	Observations over 6 days in 3 different waiting rooms, with different layouts. TV located in one corner visible to all. Trained graduate students observed every tenth visitor to the room. Actual waiting time was noted. (time of entrance to time called to physicians room). After consultation subjects were intercepted by an interviewer and asked to fill out a questionnaire.	(1) Waiting environment is a stronger determinant of service satisfaction than objective waiting time. (2) Wait environment influences the affective response to the wait; but does not have an effect on the cognitive response (long/short) of waiting time. (3) Affective response are dependent on the difference between perceived waiting time and "acceptable" waiting time. (4) Presence of TV as a source of explicit distraction did not lead to shorter perceived wait times, people viewing TV perceived the wait time as longer. Also people start viewing TV after the initial small talk or other self-paced distractions like magazine reading have been exhausted. Based on the theory, authors suggest that showing longer and less varied programs on the TV might be advisable for waiting rooms.	Time-based visual distraction vs. space-based visual distraction using a TV.	The waiting environment impacts the affective component of the wait, but not the cognitive component (which could need more dynamic distractions). Also affective responses are dependent on the difference between perceived and acceptable times, so there is a critical component of actual time that is a confound in the context of EDs. Wait times in outpatient settings are not completely comparable to ED waits that could be considerably longer.

Citation	Type of Study	Method	Findings	Visual Property/ Emotional State	Implication
Becker, F., & Douglass, S. (2008). The Ecology of the Patient Visit: Physical Attractiveness, Waiting Time and Perceived Quality of Care. *Journal of Ambulatory Care Management, 31*(2), 128-141.	Mixed methods (survey and observation)	Observations were completed by two cornell researchers and watched patients in the waiting area; recorded activities and time. Survey was administered after visit. Patients were asked by staff member to participate in survey for a study on patient satisfaction. Over 15 weeks, 205 surveys were collected from 7 practices.	The more attractive the environment, the higher the perceived quality of medical care and the greater reported reduction of anxiety. It also showed that the greater the environment's attractiveness, the more positive the reported interaction with staff. Physical attractiveness of the environment had a greater influence on perceived quality and anxiety than actual time spent waiting or time spent with the doctor. Patient perceptions of quality and anxiety relief, feeling cared for as a person, and recommending the office to others were higher in more attractive physical environments.	NA	The physical environment of healthcare facilities influences the patient's waiting experience and their perception of quality of care. A combination of both physical and social factors influence both staff and patients. Given tight budgets in healthcare construction, it would be worthwhile to better understand what specific environmental factors within the healthcare environment both staff and patients pay most attention to, and how those details impact their behavior and perceptions.

Appendix D: Articles on the Use of Visual Positive Distractions and Impact On Affective States

Article	Type of Study	Method	Findings	Visual Property/ Emotional State	Implication
Diette, G. B., Lechtzin, N., Haponik, E., Devrotes, A., & Rubin, H. R. (2003). Distraction Therapy with Nature SIghts and Sounds Reduces Pain During Flexible Bronchoscopy: A Complementary Approach to Routine Analgesia. *Chest, 123,* 941-948.	Controlled experiment	Patients undergoing fexible bronchoscopy with conscious sedation subjected to two conditions: with nature sound and view and without; patient ratings of pain control and anxiety in the intervention group compared with the control group through a multivariate logistical regression model.	Adult patients in a procedure room reported better pain control when exposed to a nature scenes with nature sound in the ceiling. No significant results with anxiety.	Nature scenes: 42 X 52-inch photographic quality mural of a mountain stream in a spring meadow that was mounted by the bedside in the recovery area, criteria for selection not listed pain perception, anxiety.	Viewing nature scenes can distract patients and positively impact their perception of pain. Viewing water scene could be uncomfortable for supine patients after a point in time (due to bladder urges). Not addressed in paper.
Miller, A. C., Hickman, L. C., & Lemasters, G. K. (1992). A distraction technique for control of burn pain. Journal of *Burn Care Rehabiitation, 13*(5), 576-580.	Controlled experiment	10-28 observations of each patient (twice per day): Patients received medication 30 minutes prior to dressing change; 15 minutes prior they filled out questionnaire. Treatment group watched Muralvision and control group did not. Immediately after dressing change (maximum 2 minutes) the questionnaires were administered again. Instruments used: Pain: The McGill pain questionnaire; anxiety: Spielberger's stat-trait anxiety inventory.	(1) Reduction in pain and anxiety was observed for the treatment group. (2) scores were generally always lower for anxiety and pain in the treatment group vs. control group.	Nature video (Muralvision designed specifically for hospitals, criteria for image selection not listed. Pain perception and anxiety.	Video of nature could be effective for both pain and anxiety. Time of exposure could be a determinant of whether still or video interventions should be used.

Article	Type of Study	Method	Findings	Visual Property/ Emotional State	Implication
Tse, M. M., Ng, J. K., Chung, J. W., & Wong, T. K. (2002). The effect of visual stimuli on pain threshold and tolerance. *Journal of Clinical Nursing, 11*(4), 462-469.	Randomized control trial	Two groups of students were randomly assigned to a soundless video group or blank screen group. Modified tourniquet pain technique used to induce pain, subjects reported pain 20 seconds after inflation and every 20 seconds thereafter, for maximum of 10 minutes. Pain threshold (time when patients recorded faint pain), pain tolerance (report intolerable pain). Paired t-test conducted to determine significant difference between pain threshold and pain tolerance with respect to visual stimuli.	Viewing natural scenery projected on to a blank screen increased the pain threshold and pain tolerance of volunteers assessing pain inflicted by a modified tourniquet device.	Videotapes showing natural environments, mountains, and waterfalls; pain threshold and tolerance.	Viewing nature videos can positively impact pain perception in the ED.
Schneider, S. M., Ellis, M., Coombs, W. T., Shonkwiler, E. L., & Folsom, L. C. (2003). Virtual reality intervention for older women with breast cancer. *Cyberpsychology Behavior, 6*(3), 301-307.	Cross-over design	Patients randomly assigned to receive distraction during one chemotherapy treatment and no distraction during the other (control). Paired t-tests used to analyse decrease in self-reported distress and anxiety scores. Instruments used: Symptom distress scale, revised Piper fatigue scale, state anxiety inventory.	Virtual reality distraction decreased chemotherapy-related anxiety in a sample of older women with breast cancer. No significant decrease in distress or fatigue was found. Average time that women thought they used virtual reality was significantly less than the actual time. While there were no significant difference in any of the measures two days after the treatment (to investigate lasting effect) a trend was seen toward lower scores.	Head-mounted display of three virtual reality scenes: Oceans Below, World of Art, and Titanic. Selection criteria not clarified. No difference between different conditions studies. Anxiety, distress, fatigue.	Virtual reality intervention resulted in reduced anxiety and reduced perception of the amount of time they thought they had been in the procedure. In the case of waiting rooms, immersive experiences like virtual reality, could help warp the perception of time. Suitable imagery could reduce anxiety.

Article	Type of Study	Method	Findings	Visual Property/ Emotional State	Implication
Ulrich, R. S., Lunden, O., & Eltinge, J. (1993). *Effects of exposure to nature and abstract pictures on patients recovering from heart surgery.* Paper presented at the Thirty-third meeting of the society of psychophysiological research, Rottach-Egern, Germany.	Controlled experiment	Compared recovery outcomes across six groups of patients assigned to different picture exposures following surgery.	Patients exposed to a representational nature image experienced less postoperative anxiety, fewer doses of strong pain medication, but a higher intake of moderate strength pain analygesic, than patients assigned to the five other visual conditons. Abstract image with rectilinear forms worsened outcomes compared to the control condition.	Nature vs. abstract, possible significance of contour, anxiety, pain.	Visual images can be restorative, but inappropriate visual images can be harmful. Abstract images, specially with rectilinear sharp forms may not be suitable.
Coss, (1990) Picture perception and patient stress: A study of anxiety reduction and postoperative stability. Unpublished paper, University of California, Davis. Protocol no.96-521R	Pre and post intervention study. Randomized controlled trial.	Systolic blood pressure and heart rate were sampled at 3-minute intervals while the patient waited in the preoperative holding area. These measures were subtracted from previous blood pressure and heart rate measures taken as the patients waited on gurneys at the elevator shortly before arriving at the preoperative holding area. Subjects were exposed to two distinct image conditions: Serene and arousing pictures based on previous research on picture perception using image rating and pupil dilation. Patients were randomly assigned to one of the two picture conditions.	Patients on gurneys viewing ceiling-mounted scenes of nature had systolic blood pressure levels 10 to 15 points lower than patients exposed to either aesthetically pleasing arousing pictures or a control condition of no picture.	Serene and arousing nature pictures; postoperative, stress, anxiety.	Not all nature images are restorative. The content of nature images must be considered carefully. Placement on the ceiling tiles also raises the issue of critical placement and sightlines in how visual art is integrated in design. Impact over an extended period of time not investigated.

Article	Type of Study	Method	Findings	Visual Property/ Emotional State	Implication
Vincent, E., Battisto, D., Grimes, L., & McCubbin, J. (2010). The effects of nature images on pain in a simulated hospital patient room. *Health Environment Research and Design Journal, 3*(3), 42-55.	Controlled experiment	Four groups were subjected to a specific nature image category of prospect, refuge, hazard, or mixed prospect and refuge; the fifth group (control) viewed no image. The short-form McGill pain questionnaire and the profile of mood states survey instruments were used to assess pain and mood, respectively. Continuous physiological readings of heart rate and blood pressure were collected. Pain was induced through a cold pressor task, which required participants to immerse their nondominant hand in ice water for up to 120 seconds.	The mixed prospect and refuge image treatment showed significantly lower sensory pain responses, and the no-image treatment indicated significantly higher affective pain perception responses. The hazard image treatment had significantly lower diastolic blood pressure readings during the pain treatment, but it also had significantly high total mood disturbance.	Nature images depicting prospect, refuge, mixed prospect and refuge, and hazard. Image selection based on Appleton's prospect refuge theory, pain, distress.	Nature images depicting a balance of prospect and refuge elements can lower the perception of pain. Sensory pain and affective pain may be impacted differently by visual images. Images that are a powerful distraction (like hazard image), are not necessarily positive unless they induce a positive mood of affective state as well.
Ulrich, R. S., Simons, R. F., & Miles, M. A. (2003). Effects of Environmental Stimulations and Television on Blood Donor Stress. *Journal of Architectural and Planning Research, 20*(1), 38-47.	Experiment	Four different environmental conditions were presented to 872 blood donors (68% males, 32% females, mean age = 40.4 years). Using wall-mounted television monitors: a videotape of nature settings, a tape of urban environments, daytime television, or a blank monitor were randomized and shown to the participants. Physiological measures (blood pressure, pulse rate) were collected and recorded for each condition.	Blood-pressure and pulse-rate findings converged to indicate that stress was lower during no television than television and during low stimulation (no television and nature) than high stimulation (television and urban). In line with evolutionary theory, pulse rates were markedly lower during nature than urban.	Nature video, urban video, television, stress.	Nature videos are more restorative than urban scenes or regular TV, in fact, uncontrollable TV conditions (where patients are not given a choice in what program to watch) could be a negative distraction.

Appendix E: Matrix of Shortlisted Neuroscience Articles

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
			FEAR			
1	Bar M., & Neta M. (2007). Visual elements of subjective preference modulate amygdala activation. *Neuropsychologia, 45*, 2191–2200.	(1) The preference bias is the result of an elevated level of arousal in the presence of sharp-angled features; an elevated arousal that stems from an implicit association of these sharp features with threat and danger. (2) The contour-based preference formation is mediated by the low spatial frequencies (LSFs) of the image, rather than the high spatial frequencies(HSFs).	Experiment1: Participants viewed one member from each pair (either the sharp-angled or the curved) and the control objects and made a like/dislike forced-choice decision during fMRI scanning. Experiment2: The same as the Experiment1 except no novel patterns, all stimuli were filtered to include either the LSFs (spatial frequencies of lower than 6, 8,or 10 cycles per image) or the HSFs (spatial frequencies higher than 24 cycles per image) that are equally recognizable. A new set of 32 participants was recruited, only rating, no fMRI. Experiment3: instead of liking, required to respond "threatening" or "non-threatening" for sharp and curve contours. No fMRI.	Compared amygdala response using fMRI between three conditions (pairs of real objects, pairs of novel patterns, control baseline objects, comprised of a mixture of curved and sharp angles) when participants viewed sharp-angled and curved objects. The semantic meaning of the objects was emotionally neutral.	Visual images: Pairs of real objects (curved or sharp edges), pairs of novel pattern, control basline objects (mixed of curved and sharp angles), a set of LSF and HSF images from real objects.	Viewers preferred objects with a curved contour compared with objects that have pointed features and a sharp-angled contour. The amygdala was more active for everyday sharp objects compared with their curved contour counterparts.

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
			FEAR			
2	Irwin, W., Davidson, R. J., Lowe, M. J., Mock, B. J., Sorenson, J. A., & Turski, P. A. (1996). Human amygdala activation detected with echoplanar functional magnetic resonance imaging. *NeuroReport, 7,* 1765–1769.	Examined human amygdalae activation in response to viewing affective visual stimuli using fMRI in a normal human sample.	fMRI was used while subjects viewed alternating blocks of affectively neutral and affectively negative still pictures.	A trial consisted of 11 blocks of five valence constant pictures, with each picture presented for 6.6 seconds. The control trial consisted of blocks of only positive pictures. The second trial consisted of alternating blocks of neutral and negative pictures, always beginning and ending with a neutral block.	Neutral pictures (e.g., a book) or negative (e.g., a mutilated face), moderately positive pictures (e.g., sunset) were selected for a control trial.	fMRI signal intensity within the amygdala was greater when subjects viewed graphic photographs of negative material (mutilated human bodies) than when they viewed neutral pictures. (Only negative affect was manipulated in their paradigm.)
3	Adolphs, R., Tranel, D., Hamann, S., Young, A. W., Calder, A. J., & Phelps, E. A. (1999). Recognition of facial emotion in nine individuals with bilateral amygdala damage. *Neuropsychologia, 37*, 1111–1117.	(1) Investigated that bilateral amygdala damage would impair the recognition of fear in facial expressions. (2) Impairments in recognizing facial emotion would not be restricted to fear, but rather would encompass a class of emotions related to threat and danger. (3) Explore the reasons that individuals with bilateral amygdala damage might be impaired in recognizing facial emotion.	Subjects were shown slides of the faces of six different individuals each displaying six different basic emotions (happiness, surprise, fear, anger, disgust, sadness) and three neutral faces, for a total of 39 stimuli. Ratings were given on a scale of 0 (least) to 5 (most). No feedback was given to the subject to indicate what emotion the stimuli were showing.	All 39 stimuli were presented in random order with no time limit. The 39 stimuli were shown six times in separate blocks, and subjects rated the stimuli with respect to the intensity of each of the six basic emotions, rating one emotion in each of the six blocks. Thus, for a particular facial expression of, say, happiness, subjects would be asked to rate the face with respect to the intensity shown of happiness, surprise, fear, anger, disgust, and sadness.	Six different basic emotions (images of facial expressions depicting happiness, surprise, fear, anger, disgust, sadness) and three neutral faces	Subjects with bilateral amygdala damage were impaired in rating facial emotion, compared to brain-damaged controls (without amygdala damage). Impaired recognition of fear is due to damage to a more general neural system for recognizing emotions that signal potential harm to the organism and would include fear and anger.

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
			FEAR			
4	Whalen, P. J., Rauch, S. L., Etcoff, N. L., McInerney, S. C., Lee, M., & Jenike, M.A. (1998). Masked presentations of emotional facial expressions modulate amygdala activity without explicit knowledge. *Journal of Neuroscience, 18,* 411–418	The present study used fMRI during the presentation of backwardly masked facial expressions to determine whether amygdala activation might be demonstrated in humans in the absence of explicit knowledge.	Subjects were presented with alternating 28-second epochs of masked fearful face targets, masked happy face targets, or a single cross that served as a low level fixation condition. After the completion of all stimulus presentations, subject were asked to describe any aspect of the presented faces. Next, the subjects were asked to comment on the emotional expressions of the faces. Then the subjects were asked if they had seen any happy or smiling faces and asked if they had seen any fearful or afraid faces. Finally, the subjects were shown all face stimuli (fearful, happy, and neutral) and asked to point out the specific faces they had referred to in response to earlier questions.	Subjects viewed either 56 masked fearful stimuli or 56 masked happy stimuli during scanning. Masked stimuli were presented twice per second in a random order. Each 200 millisecond masked stimulus consisted of a 33 millisecond fearful or happy expression (target) immediately followed by a 167 millisecond neutral expression (mask).	Face stimuli consisted of fearful, happy, and neutral expressions of eight individuals.	Although subjects reported seeing only neutral faces, blood-oxygen level dependent (BOLD) signal in the amygdala was significantly higher during viewing of masked fearful faces than during the viewing of masked happy faces, demonstrating that human amygdala activation in response to emotionally valenced stimuli is a reliable phenomenon. Demonstrated isolated amygdala activation in response to masked presentations of facial expressions that prevented explicit knowledge. These data underscore the automaticity of the processing of the emotional facial expressions of the amygdala and are consistent with data implicating the amygdala in the nonconscious monitoring of emotional stimuli.

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
			FEAR			
5	Whalen, P. J., Shin, L. M., McInerney, S. C., Fischer, H., Wright, C. I., & Rauch, S. L. (2001). A functional MRI study of human amygdala responses to facial expressions of fear versus anger. *Emotion, 1*, 70–3.	Test the hypotheses that the amygdala functions to resolve biologically relevant associative ambiguity, and this role explains its greater processing of fearful facial expressions.	Healthy subjects were presented with fearful face, angry face, and neutral face stimuli in fMRI scanner.	During scanning, participants viewed 48 fearful, 48 angry, or 48 neutral faces, each stimulus was presented for 200 millisecond at an interstimulus interval of 500 millisecond.	Pictures of human faces bearing expressions of fear or anger, as well as faces with neutral expressions.	Activity in the amygdala is greater to fearful facial expressions compared to neutral or angry faces.
6	Whalen, P. J. (1998). Fear, vigilance, and ambiguity: Initial neuroimaging studies of the human amygdala. *Current Directions in Psychological Science, 7*, 177–188.	Discuss results from human neuroimaging studies demonstrating activation of the amygdala in normal human subjects. These studies offer support for the usefulness of conceptualizing the amygdala as a necessary part of the fear system. They also offer data consistent with an existing animal literature suggesting a more generalized function for the amygdala.	Literature review	Literature review	N/A	Amygdala activated in response to stimuli that most likely produce fear (electric shock, disturbing pictures), Also, activated in response to facial expression.

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
			FEAR			
7	Vuilleumier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2003). Distinct spatial frequency sensitivities for processing faces and emotional expressions. *Natural Neuroscience, 6,* 624–631.	Used face stimuli with different spatial frequencies to investigate whether the amygdala and ventral visual cortex have different inputs in the normal human brain.	During whole-brain scanning, participants judged the gender of a face that showed either a fearful or neutral expression and had one of three spatial frequency contents: an intact broad spatial frequency (BSF), HSF alone, or LSF alone.	During fMRI scanning, participants judged the gender of a face that showed either a fearful or neutral expression and had one of three spatial frequency contents: an intact broad spatial frequency (BSF), HSF alone, or LSF alone. Different stimulus types were presented in random order, with emotional expression irrelevant to the gender task.	240 images (40 per cell) with either a fearful or neutral expression, and either a BSF, HSF, LSF	Neural responses in fusiform cortex and effects of repeating the same face identity upon fusiform activity were greater with intact or HSF face stimuli than with LSF faces, regardless of emotional expression. In contrast, amygdala responses to fearful expressions were greater for intact or LSF faces than for HSF faces.

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
			FEAR			
8	Britton, J. C. (2006). Facial expressions and complex IAPS pictures: Common and differential networks. *NeuroImage, 31,* 906–919.	Test the hypothesis that facial expressions and IAPS pictures would activate a similar emotional network, and that some brain regions (superior temporal gyrus and amygdala) would preferentially respond to facial expressions.	Compared blood-oxygen level dependent (BOLD) activation patterns to facial expression of emotions and to complex emotional pictures from the IAPS to determine if these stimuli would activate similar or distinct brain regions.	Experiment 1: Volunteers participated in separate rating-task experiments; Group 1: IAPS rating task, Group 2: Face rating task. After viewing an image for 3 seconds, participants were prompted to rate each image. IAPS group rated images on predominant emotion and emotion intensity. Facial expression group rated images on predominant emotion, emotion intensity, valence, and arousal. Experiment 2: During fMRI scanning, expressive faces and IAPS pictures were interwoven with control periods. Images for each specific emotion block (happy, neutral, sad, anger, fear) were identified using the emotional ratings and emotional intensities obtained in the behavioral experiment. Participants passively viewed each image and responded via button press using the right index finger to indicate when a new image appeared on the screen.	The image set included 150 facial expressions of specific emotions posed and evoked by actors balanced for gender and ethnicity and 200 IAPS pictures. These images were selected to target the emotions of happiness (babies, Mickey Mouse, sporting events), sadness (funeral scenes/ cemeteries, premature babies, wounded bodies), anger (human violence, guns, KKK images), and fear (snakes,spiders, sharks, medical procedures) in equal quantities. In addition, neutral or nonemotional images (mushrooms, household items) were also selected.	Both faces and IAPS pictures activated similar structures, including the amygdala, posterior hippocampus, ventromedial prefrontal cortex, and visual cortex. In addition, expressive faces uniquely activated the superior temporal gyrus, insula, and anterior cingulate more than IAPS pictures, despite the faces being less arousing. For the most part, these regions were activated in response to all specific emotions; however, some regions responded only to a subset.

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
			FEAR			
9	Chiao, J. Y., Iidaka, T., Gordon, H. L., Nogawa, J., Bar, M., Aminoff, E., et al. (2008). Cultural specificity in amygdala response to fear faces. *Journal of Cognitive Neuroscience, 20*(12), 2167–2174.	Find out how culture influences neural responses to fear stimuli. Hypothesis: The human amygdala would respond preferentially to fear expressed by members of one's own vs. other cultural group, but not to other types of emotions such as happiness or anger.	Used fMRI to measure amygdala response to fear and nonfear faces in two distinct cultures: Native Japanese and Caucasians in the United States.	The study consisted of four event-related functional runs, with 80 trials each. Each trial began with the presentation of a facial photograph (1,500 millisecond) followed by a blank screen (500 millisecond), and then fixation (3,000 millisecond). Trials were separated by a centered fixation. For each trial, participants made an emotion categorization judgment (e.g., fear, angry, happy, or neutral) using one of four button presses.	Images: Digitized grayscale pictures of 80 faces, each with either a fearful, a neutral, a happy, or an angry expression taken from Japanese and Caucasian posers (20 men and 20 women from each cultural group) were used.	Amygdala responsivity increases when fear is detected in members of one's own relative to other cultural groups.
10	Anders, S., Eippert, F., Weiskopf, N., & Veit, R. (2008). The human amygdala is sensitive to the valence of pictures and sounds irrespective of arousal: An fMRI study. *SCAN, 3,* 233–243.	Determine (1) whether the amygdala is sensitive to the valence of pictures and sounds equated for arousal and (2) whether increasing amygdala activity in response to emotional pictures and sounds is better explained by valence than by arousal.	Investigated amygdala activity in response to visual and auditory stimuli. By selecting stimuli based on individual valence and arousal ratings, researchers were able to dissociate stimulus valence and stimulus-related arousal.	Visual stimuli included 40 pictures selected from the IAPS. Pictures depicted one to three humans or animals. Both visual and auditory stimuli varied largely and independently in published valence and arousal ratings obtained from a large American sample. After the scanning procedure, all stimuli were presented outside the scanner, and subjects were asked to rate how pleasant or unpleasant and how arousing they had experienced each stimulus during scanning.	Visual stimuli with different valence and arousal and auditory stimuli.	The amygdala responded to both negative and positive stimuli, and this response did not increase with arousal. In contrast, thalamic and cortical activity increased with arousal. Negative and positive stimuli activated both common and distinct cortical regions. While the right caudolateral orbitofrontal cortex responded to emotional stimuli of either valence, responses in the left caudolateral orbitofrontal region were confined to negative stimuli. Activity in response to negative and positive arousing stimuli overlapped in the orbital part of the inferior frontal gyrus in the right hemisphere and in a region in the dorsomedial prefrontal cortex corresponding to the supplementary motor area.

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
				FEAR		
11	Simmons, A., Matthews, S. C., Stein, M. B., & Paulus, M. P. (2004). Anticipation of emotionally aversive visual stimuli activates right insula. *Neuroreport, 15,* 2261–2265.	Aim to identify the neural circuitry involved in anticipating aversive affective stimuli.	After completion of the task, individuals rated all 30 images. The anticipation task combined a continuous performance task with the intermittent presentation of aversive affective stimuli.	During the continuous performance task in the fMRI scanner, subjects were asked to press a left mouse button when they saw a circle and a right mouse button when they saw a square on the screen. Subjects were instructed that during the task the pitch of the tone would change 4–6 seconds before the appearance of a picture of a spider or a snake on the screen.The total duration of the task was 512 seconds. Behavioral data were collected and scored for accuracy and latency of response during the continuous performance task. No response was required when an image of a snake, spider, or fixation cross was presented on the screen.	Pictures of spiders and snakes.	During the high-tone condition relative to the low- tone condition, which signifies the anticipation period, activation was observed in right inferior frontal gyrus, right parahippocampal gyrus, right insula, and right middle frontal gyrus.
12	Simmons, A., Strigo, I., Matthews, S., Paulus, M., & Stein, M. (2006). Anticipation of adverse visual stimuli is associated with increased insula activation in anxiety-prone patients. *Biological Psychiatry, 60,* 402–409.	Aim to test the hypothesis that individuals with anxiety-prone (AP) relative to anxiety-normative (AN) subjects would show an exaggerated insula response during anticipation of an aversive image.	Before scanning, subjects gave a subjective rating of fear of snakes and spiders. In fMRI scanner, Subjects were prompted 4–6 sec before the onset of each aversive image. Blood-oxygen level dependent (BOLD) signal was contrasted during cued anticipation of images vs. nonanticipatory task performance as well as viewing images.	During the continuous performance task, subjects were asked to press a left mouse button whenever they saw a circle and a right mouse button whenever they saw a square on the screen. Subjects were instructed that during the task the pitch of the tone would change, 4–6 seconds before the appearance of a picture of a spider or a snake on the screen. The total duration of the task was 512 seconds. Behavioral data were collected and scored for accuracy and latency of response during the continuous performance task. No response was required when an image of a snake, spider, or fixation cross was presented on the screen.	Pictures of spiders and snakes.	(1) AP subjects showed greater response than AN subjects in the bilateral insula during anticipation. (2) These individuals had lower activity within the superior/medial frontal gyrus. During the image presentation phase, AN subjects showed greater activation than AP subjects in the bilateral temporal lobes and left superior frontal gyrus. Moreover, bilateral temporal lobe activation during image presentation was inversely correlated with bilateral insula activation during anticipation both within groups and in the combined group.

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
				FEAR		
13	Nitschke, J. B., Sarinopoulos, I., Mackiewicz, K. L., Schaefer, H. S., & Davidson, R. J. (2006). Functional neuroanatomy of aversion and its anticipation. *NeuroImage, 29,* 106–116.	Investigated the functional neuroanatomy of processing aversive stimuli.	During the fMRI experiment, subjects viewed 252 pictures. No response was required. There were 42 trials (21 aversive and 21 neutral presented in pseudo-random order) in each of the three functional scans of the fMRI experiment.	Each trial began with a 0.5 seconds warning cue (minus sign for aversive pictures, circle for neutral pictures) followed by a 2.5 seconds or 4.5 seconds black screen (pseudorandomized within valence) and then two contiguous 0.5 seconds presentations of either aversive or neutral pictures. Another black screen for 16 or 18 seconds ended each 22 seconds trial.	Aversive and neutral images from IAPS.	Brain areas jointly activated by the anticipation of and exposure to aversive pictures included the dorsal amygdala, anterior insula, dorsal anterior cingulate cortex, right dorsolateral prefrontal cortex, and right posterior orbitofrontal cortex.
14	Stein, M. B., Simmons, A. N., Feinstein, J. S., & Paulus, M. P. (2007). Increased amygdala and insula activation during emotion processing in anxiety-prone subjects. *American Journal of Psychiatry, 164,* 318–327.	Test the hypothesis that relative to subjects with normative levels of anxiety proneness, high anxiety-prone individuals show exaggerated activation in the amygdala and insula during an emotional face paradigm.	Subjects participated in fMRI during an emotion face assessment task that has been shown to reliably engage amygdala and associated limbic structures.	During each 5-second trial, a subject was presented with a target face (on the top of the computer screen) and two probe faces (on the bottom of the screen) and was instructed to match the probe with the same emotional expression to the target by pressing the left or right key on a button box.	Images of face expression (angry, fearful, or happy).	Anxiety-prone subjects had significantly greater bilateral amygdala and insula activation to emotional faces than did the anxiety-normative comparison subjects (relevant to expressions and selection of figurative faces).

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
			PAIN			
15	Gu, X., & Han, S. (2007). Attention and reality constraints on the neural processes of empathy for pain. *Neuroimage, 36*(1), 256-67.	Investigated whether the neural correlates of empathic processes of pain are altered by task demand and prior knowledge of stimulus reality.	Subjects were scanned using fMRI while watching pictures or cartoons of hands that were in painful or neutral situations.	Each session contained six blocks of trials that varied in stimuli and task: (1) rating pain intensity of hands in painful pictures and painful cartoons; (2) counting the number of hands in painful pictures, neutral pictures, painful cartoons, neutral cartoons. In the pain judgment tasks, subjects judged the pain intensity felt by the person depicted in the pictures. Each block started with the presentation of instructions for 3 seconds, which defined the task (i.e., rating pain intensity or counting the number of hands) for each block of trials.	Pictures or cartoons of hands that were in painful (e.g., a hand trapped in a door) or neutral situations.	Findings indicate that the involvement of the neural substrates underlying pain-related empathy is constrained by top–down attention and contextual reality of stimuli.
16	Ogino, Y., Nemoto, H., Inui, K., Saito, S., Kakigi, R., & Goto, F. (2007). Inner experience of pain: Imagination of pain while viewing images showing painful events forms subjective pain representation in human brain. *Cereb Cortex, 17*(5), 1139–1146.	Compared cerebral hemodynamic responses during the imagination of pain with those to emotions of fear and rest.	Subjects viewed two counterbalanced blocks of images from IAPS in fMRI scanner, images showing painful events and those evoking emotions of fear and rest. They were instructed to imagine pain in their own body while viewing each image showing a painful event.	The stimulus materials consisted of 45 images belonging to three emotional categories: Images showing painful events (pain condition), images evoking fear (fear condition), and images evoking rest (rest condition) (15 each). In each block, five images of the same emotional category were presented for every 6 seconds.	Images showing painful events and those evoking emotions of fear and rest.	The imagination of pain is associated with increased activity in brain regions involved in the pain-related neural network: the anterior cingulate cortex (ACC), right anterior insula, cerebellum, posterior parietal cortex, and secondary somatosensory cortex region. Whereas increased activity in the ACC and amygdala is associated with the viewing of images evoking fear.

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
			PAIN			
17	Roy, M., Piche, M., Chen, J. I., Peretz, I., & Rainville, P. (2009). Cerebral and spinal modulation of pain by emotions. *Proceedings of the Natlonal Academy of Sciences, 106*(49), 20900–20905.	Explore the neural mechanisms involved in the emotional modulation to painful electrical stimulations induced by pleasant or unpleasant pictures.	Combined the recording of a spinal nociceptive reflex (RIII reflex), as an index of spinal nociception, with fMRI in a paradigm investigating the emotional modulation of pain.	Two electrical stimuli were delivered during each block of visual stimulation, 2,700 milliseconds after the onsets of the second and fourth picture. At the end of each block of pictures, participants had 18 seconds to rate the pain elicited by the electrical stimulation on a visual analogue scale.	Ninety pictures that evoked pleasant (erotic couples and outdoor sports), unpleasant (images of threats or mutilations), or neutral emotions (household objects and outdoor scenes) were selected from the IAPS.	Emotions induced by pleasant or unpleasant pictures modulated the responses to painful electrical stimulations in the right insula, paracentral lobule, parahippocampal gyrus, thalamus, and amygdala.
18	Van Middendorp, H., Lumley, M. A., Jacobs, J. W., Bijlsma, J. W., & Geenen, R. (2010). The effects of anger and sadness on clinical pain reports and experimentally-induced pain thresholds in women with and without fibromyalgia. *Arthritis Care Res (Hoboken), 62,* 1370–1376.	Examined the effects of anger and sadness on clinical pain reports and on pain threshold and tolerance in response to electrical stimulation in women with and without fibromyalgia.	NA	In an experimental study, 62 women with fibromyalgia and 59 women without fibromyalgia recalled a neutral situation, followed by recalling both an anger-inducing and a sadness-inducing situation, in counterbalanced order. The effect of these emotions on pain responses (noninduced clinical pain and experimentally induced sensory threshold, pain threshold, and pain tolerance) was analyzed with a repeated-measures analysis of variance.	NA	The experience of both anger and sadness amplifies pain in women with and without fibromyalgia.

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
			PAIN			
19	Yoshino, A., Okamoto, Y., Onoda, K., Yoshimura, S., Kunisato, Y., Demoto, Y., et al. (2010). Sadness enhances the experience of pain via neural activation in the anterior cingulate cortex and amygdala: An fMRI study. *NeuroImage, 50,* 1194–1203.	Test the hypothesis that emotional stimuli (sad, happy, and neutral) might modulate subjective pain sensitivity and neural responses to painful stimuli and to reveal a possible association between pain perception and the contexts evoked by emotional stimuli.	Pain-inducing stimuli were presented in a fMRI scanner during different emotional contexts, which were induced via the continuous presentation (5 seconds) of sad, happy, or neutral pictures of faces.	Eight sad, eight happy, or eight neutral facial expressions displayed by eight different identities were taken from a standardized series of stimuli and were presented for 5 seconds each, with a 1 second interstimulus interval. Each face was randomly used across 60 trials, with a total of 180 trials being conducted. The total experimental duration was 18 minutes.	Visual emotional stimuli (sad, happy, and neutral faces) and electrical stimuli.	Subjective pain ratings were higher in the sad emotional context than in the happy and neutral contexts, and that pain-related activation in the anterior cingulate cortex was more pronounced in the sad context relative to the happy and neutral contexts.
20	Saarela, M.V, Hlushchuk, Y., Williams, M.S., Schurmann, M., Kalso, E., & Hari, R. (2007). The compassionate brain: Humans detect intensity of pain from another's face. *Cereb Cortex, 17*(1), 230–7.	Understanding another person's experience draws on "mirroring systems," brain circuitries shared by the subject's own actions/ feelings and by similar states observed in others.	Imaged brain activity in 12 subjects while they viewed photographs of faces of patients, whose pain was transiently intensified for a few seconds. The subjects estimated the pain intensity in each face stimulus.	Brain scanning consisted of two sessions, one with the provoked and chronic pain faces and the other with the neutral faces of healthy individuals in their 20 seconds. During the pain-face sequence, the photos of provoked and chronic pain of the same patient were presented in pairs. Each photo was displayed for 2.5 seconds. The intrapair interval was 2.5-7.5 seconds, and the between-pair interval was 15 seconds.	Photographs of faces of chronic pain patients and healthy volunteers.	Not only the presence of pain but also the intensity of the observed pain is encoded in the observer's brain—as occurs during the observer's own pain experience. When subjects observed pain from the faces of chronic pain patients, activations in bilateral anterior insula, left anterior cingulate cortex, and left inferior parietal lobe in the observer's brain correlated with their estimates of the intensity of observed pain.

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
			PAIN			
21	Proverbio, A. M., Adorni, R., Zani, A., & Trestianu, L. (2009). Sex differences in the brain response to affective scenes with or without humans. *Neuropsychologia, 47,* 2374–2388.	Investigated whether the two sexes differed in their cerebral responses to affective pictures portraying humans in different positive or negative contexts compared to natural or urban scenarios.	IAPS slides were presented to 24 Italian students. Half the pictures displayed humans while the remaining scenes lacked visible persons. Event-related potentials were recorded from 128 electrodes.	512 pictures (440 affective pictures plus 72 targets) were randomly presented in 16 different runs. Each run consisted of 27–28 affective pictures and at least three to six targets, lasted for about 2 minutes 49 seconds and was preceded by three visual warning stimuli.	Half the pictures showed humans in explicitly positive (visibly happy, loving, or comfortable) or negative contexts (visibly anguished, terrified, agonizing, distressed, at risk of their lives, tortured, or dead). The remaining 220 slides showed positive or negative ecological scenes without visible persons (desolated and devastated war scenario; hurricanes; car or plane crashes; repulsive insects; suffering, tortured, or dead animals—as opposed to attractive food, wonderful natural landscapes, brand new Ferrari, cute little puppies, and so on).	Women might be more reactive than men to viewing painful stimuli (vicarious response to pain) and therefore more empathic.
22	Sengupta, S., & Kumar, D. (2005). Pain and emotion: Relationship revisited. *German Journal of Psychiatry, 8,* 85-93.	This article attempts an in-depth study of the relationship of pain and psychiatric disorders in order to make a case for modulation of pain by emotions.	Examine the strength of the case for modulation of pain by emotion from the following perspectives: (1) Interface of pain and psychiatry; (2) Poor relation between the physical findings and the level of perceived pain and disability; (3) Neuroanatomic basis of perception of pain; (4) Imaging studies on perception of pain; (5) Current definition & nosology of pain; (6) Assessment of pain; (7) Chronic pain, neuropathic pain, and fibromyalgia.	Literature review	NA	The pain is an experience comprising of nociception and perception and so all the mental processes involved in complex perception also influence the experience of pain. Effective pain management must include a multidisciplinary approach.

No.	Citation	Aim of the Study/ Hypothesis	Study Design	Research Methods	Stimuli Used	Major Findings
			PAIN			
23	Cheng, Y., Lin, C. P., Liu, H. L., Hsu, Y. Y., Lim, K. E., Hung, D., et al. (2007). Expertise modulates the perception of pain in others. *Current Biology, 17,* 1708–1713.	Investigated the difference in the neurohemodynamic response between two groups of participants.	In this fMRI study, physicians who practice acupuncture were compared to naive participants while observing animated visual stimuli depicting needles being inserted into different body parts, including the mouth region, hands, and feet.	Two groups of subjects were scanned while watching dynamic visual stimuli depicting body parts in both nonpainful situations (being touched with a Q-tip) and (potentially painful) acupuncture (being pricked by needles) situations.	Visual stimuli depicting body parts in both nonpainful situations (being touched with a Q-tip) and (potentially painful) acupuncture (being pricked by needles) situations.	Results indicate that the anterior insula somatosensory cortex, periaquedual gray, and anterior cingulate cortex were significantly activated in the control group, but not in the expert group, who instead showed activation of the medial and superior prefrontal cortices and the temporoparietal junction, involved in emotion regulation and theory of mind.
24	Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: A meta-analysis of emotion activation studies in PET and fMRI. *NeuroImage, 16,* 331–348.	Determine if common or segregated patterns of activations exist across various emotional tasks.	Reviewed 55 PET and fMRI activation studies which investigated emotion in healthy subjects.	Characterized each region by its responsiveness across individual emotions (positive, negative, happiness, fear, anger, sadness, disgust) to different induction methods (visual, auditory, recall/imagery) and in emotional tasks with and without cognitive demand.	Visual, auditory, and recall.	Our review yielded the following summary observations: (1) The medial prefrontal cortex had a general role in emotional processing, (2) fear is specifically engaged the amygdala, (3) sadness was associated with activity in the subcallosal cingulate, (4) emotional induction by visual stimuli activated the occipital cortex and the amygdala, (5) induction by emotional recall/imagery recruited the anterior cingulate and insula, (6) emotional tasks with cognitive demand also involved the anterior cingulate and insula. This review provides a critical comparison of findings across individual studies and suggests that separate brain regions are involved in different aspects of emotion.

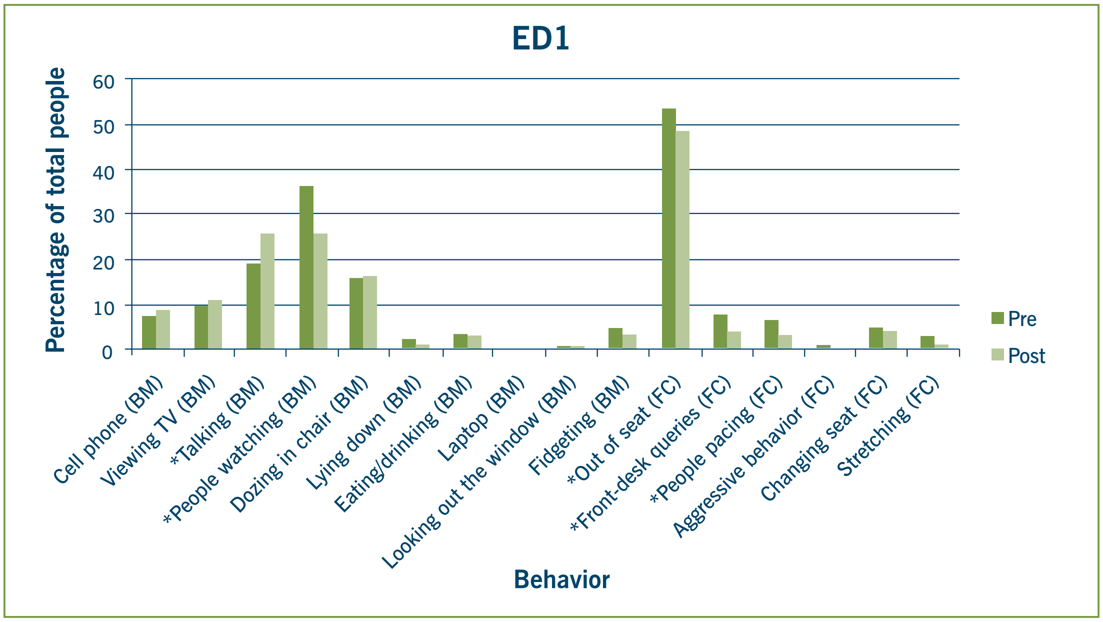
Appendix G: Breakdown of Wait Times During Data Collection

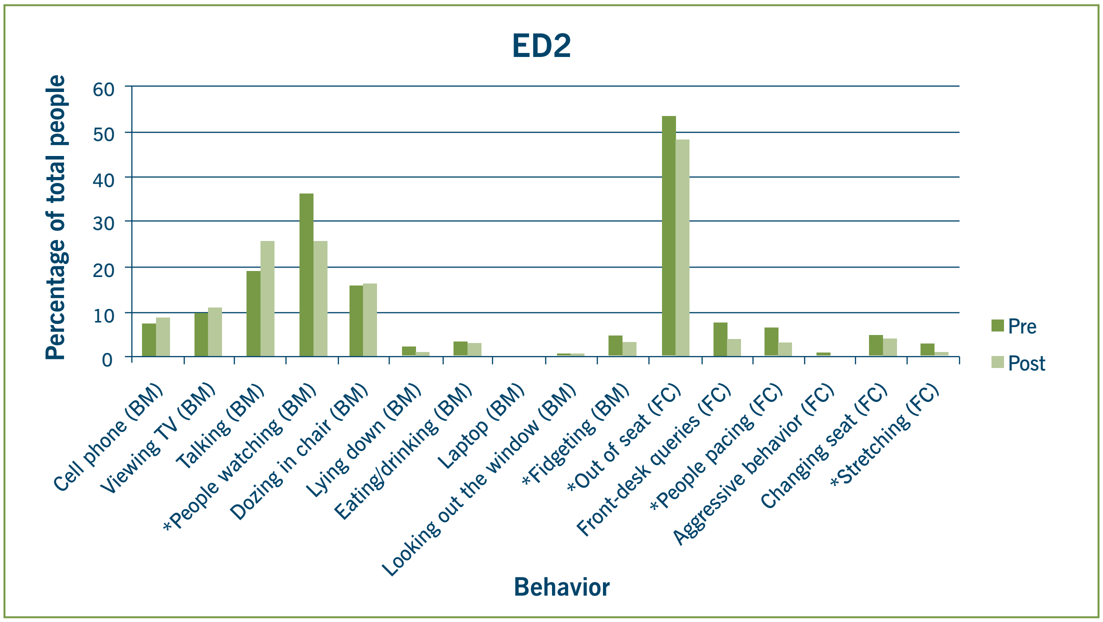
Month	Sept '09	Oct '09	Nov '09	Jan '10	Feb '10	Mar '10
ED1						
Total length of stay for all services (hours)	9:00	8:21	7:53	8:13	7:26	8:17
Arrival to triage (minutes)	32	25	22	23	22	29
Triage to bedding (hours)	1:51	1:11	0:54	0:59	0:54	1:14
Bed to disposition (hours)	7:31	7:06	6:53	7:18	6:31	7:00
ED2 (Admitted/Discharged)						
Total turnaround (hours)	6.3/ 5.0	6.2/5.0	6.4/5.1	6.3/4.9	6.0/4.5	6.8/5.1
Arrival to completion of care (hours)	4.2/4.5	4.2/4.5	4.3/4.6	4.0/4.4	3.7/4.0	4.0/4.6
Completion of care to departure (hours)	2.1/0.5	2.0/0.5	2.1/0.5	2.3/0.5	2.3/0.5	2.8/0.5

Note: December 2009 was the installation of art, not included in the study.

Appendix H: Analysis and Results

H1: Histograms of Behaviors Pre and Post





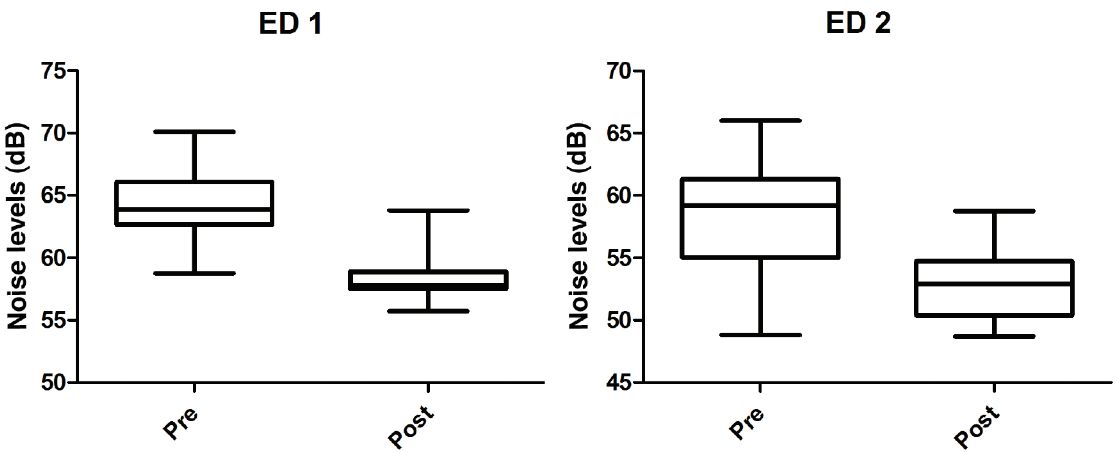
H2: ANOVA Results for Distraction/Non-distraction Activities

ANALYSIS	ED1				ED2			
TWO-WAY ANOVA	**DISTRACTION ACTIVITY**				**DISTRACTION ACTIVITY**			
Source of Variation	**Df**		**F**	**P value**	**Df**		**F**	**P value**
Interaction	4		1.011	0.4022	4		5.824	0.0002
Column factor (pre-post)	1		0.185	0.6674	1		0.1058	0.7452
Row factor (distraction activities)	4		126.6	< 0.0001	4		61.98	< 0.0001
Bonferroni Post Tests (ANOVA)	**Pre**	**Post**	**t**	**P value**	**Pre**	**Post**	**t**	**P value**
Using cell Phone	0.07823	0.08474	0.7262	P > 0.05	**0.07823**	0.08474	0.7262	P > 0.05
Viewing TV	0.1144	0.1276	1.47	P > 0.05	0.1144	0.1276	1.47	P > 0.05
Reading	0.0501	0.03906	1.231	P > 0.05	0.0501	0.03906	1.231	P > 0.05
Using laptop	0.002195	0.001174	0.1139	P > 0.05	0.002195	0.001174	0.1139	P > 0.05
Looking out of window	0.007118	0.008111	0.1108	P > 0.05	0.007118	0.008111	0.1108	P > 0.05
TWO-WAY ANOVA	**NON-DISTRACTION ACTIVITY**				**NON-DISTRACTION ACTIVITY**			
Source of Variation	**Df**		**F**	**P value**	**Df**		**F**	**P value**
Interaction	4		8.646	< 0.0001	4		6.02	0.0001
Bonferroni Post Tests (ANOVA)	**Pre**	**Post**	**t**	**P value**	**Pre**	**Post**	**t**	**P value**
Talking	0.1807	0.2317	2.678	P < 0.05	0.2583	0.31	0.4691	P > 0.05
People watching	0.3499	0.2489	5.303	P<0.001	0.2152	0.07922	3.645	P<0.01
Dozing	0.1735	0.184	0.5503	P > 0.05	0.0413	0.02706	0.7038	P > 0.05
Lying down	0.02467	0.01505	0.5052	P > 0.05	0.1669	0.178	0.1364	P > 0.05
Eating/drinking	0.03297	0.03403	0.0557	P > 0.05	0.0036	0.003632	3.063	P < 0.05

H3: ANOVA Results for Restless/Anxious Behavior

ED1							
Two-Way ANOVA	**Df**		**F**		**P value**		
Interaction		6	2.736		0.0129		
Column factor (pre-post)		1	22.1		< 0.0001		
Row factor (restless activities)		6	606.2		< 0.0001		
Bonferroni Post Tests (ANOVA)	**Pre**	**Post**	**t**	**P value**	**Welch's Corrected T-Test**	**Df**	**P value**
Fidgeting	0.0171	0.001228	0.2536	ns	2.820	29	0.0086
Front-desk queries	0.1023	0.07846	0.3766	ns	0.8140	46	ns
Pacing	0.2621	0.07514	2.954	P < 0.05	1.348	29	ns
Aggressive behavior	0.0078	0.003009	0.07582	ns	0.8229	41	ns
Getting out of seat	0.7498	0.4782	4.292	P<0.001	3.142	55	0.0027
Changing seat	0.0566	0.02739	0.4612	ns	1.377	51	ns
Stretching	0.075	0.01409	0.9626	ns	2.282	30	0.0297
ED2							
Two-Way ANOVA	**Df**		**F**		**P value**		
Interaction		6	2.661		0.0153		
Column factor (pre-post)		1	12.58		0.0004		
Row factor (restless activities)		6	46.97		< 0.0001		
Bonferroni Post Tests (ANOVA)	**Pre**	**Post**	**t**	**P value**	**Welch's Corrected T-Test**	**Df**	**P value**
Fidgeting	0.0171	0.001228	0.2536	ns	2.820	29	0.0086
Front-desk queries	0.1023	0.07846	0.3766	ns	0.8140	46	ns
Pacing	0.2621	0.07514	2.954	P < 0.05	1.348	29	ns
Aggressive behavior	0.0078	0.003009	0.07582	ns	0.8229	41	ns
Getting out of seat	0.7498	0.4782	4.292	P<0.001	3.142	55	0.0027
Changing seat	0.0566	0.02739	0.4612	ns	1.377	51	ns
Stretching	0.075	0.01409	0.9626	ns	2.282	30	0.0297

Appendix H4: Noise Results



LEGEND					
ED 1	Pre	Post	**ED 2**	Pre	Post
Number of values	29	24	Number of values	27	13
Minimum	58.75	55.70	Minimum	48.83	48.70
Maximum	70.10	63.80	Maximum	66.00	58.75
Mean	64.15	58.32	Mean	58.68	52.99
Standard deviation	2.935	1.769	Standard deviation	4.191	2.971
Mann Whitney Test- P value	< 0.0001		Mann Whitney Test- P value	<0.0001	

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