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Quantifying the Relationship Among Hospital Design, Satisfaction, and Psychosocial Functioning in a Pediatric Hematology-Oncology Inpatient Unit

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Abstract

Increasingly, empirical support demonstrates that the built environment may affect the physical and psychosocial well-being of patients, their families, and hospital staff (Beauchemin & Hays, 1996; Rubin, Owens, & Golden, 1998; Sherman, Varni, Ulrich, & Malcarne, 2005; Ulrich, 1991; Varni et al., 2004; Whitehouse et al., 2001). Investigators posit two mechanisms through which the built environment can impact patients: indirectly, by enhancing the quality of care and helping a patient feel more relaxed; and/or directly, by altering the physiological recovery process (Malcolm, 1992). Several literature reviews have been published on the relationship between the hospital built environment and patient outcomes (Joseph, Keller, & Kronick, 2008; Rubin et al., 1998; Sherman, Shepley, & Varni, 2005; Ulrich, Quan, Zimring, Joseph, & Choudhary, 2004). In their 1998 review, Rubin et al. found studies linking environment with a number of health and satisfaction outcomes but little research that had been conducted in a scientifically valid manner. Ulrich et al.'s 2004 review of the role of the physical environment in hospital design identified a number of more rigorously conducted studies, focusing mainly on adult environments and on issues of medical safety and hospital-acquired infection rates. Their conclusions linked environmental features such as noise to an increase in perceived stress and physiological arousal; exposure to natural light to reductions in depression, length of hospital stay, and pain medications and to improved sleep; and hospital gardens to improved physical and psychosocial functioning (Ulrich et al., 2004).

Two recent reviews (Joseph et al., 2008; Sherman, Shepley, et al., 2005) identified studies conducted in pediatric environments; however, the majority of these studies were set in

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neonatal intensive care units (NICUs). The handful of non-NICU studies noted the positive effects associated with exposure to music and access to hospital gardens on hospitalized children, and they found that single-occupancy patient rooms were typically linked to higher patient and family satisfaction. Sherman, Shepley, and Varni's review also identified studies measuring the impact of environmental variables on children in nonhospital environments (e.g., schools, neighborhoods, homes) with outcomes focused more on psychosocial than physiological functioning. Better behavior and attention were associated with exposure to nature; noise, even at normal to moderate levels, was associated with physiological and psychological stress and poorer cognitive functioning; and crowding, both spatial and social, was associated with poorer cognitive, psychological, physiological, and behavioral functioning. Additionally, Sherman, Shepley, and Varni's review identified studies linking environmental satisfaction and perceived control over the environment with mood and affective functioning, such that individuals who were more satisfied with their environment or felt a greater sense of control also reported better mood states.

Considering the body of research as a whole, benefits seem to be associated with access to windows and nature views, art that is nature focused, the cleanliness of facilities, the spaciousness of rooms, a sense of control over the environment, and privacy (Beauchemin & Hays, 1996; Eisen, Ulrich, Shepley, Varni, & Sherman, 2008; Joseph et al., 2008; Rubin et al., 1998; Sherman, Shepley, et al., 2005; Ulrich, 1991, 1999; Ulrich et al., 2004; Varni et al., 2004; Whitehouse et al., 2001). Rubin et al. (1998) identified the need for future research on (1) patient groups that would most likely benefit from environmental changes; (2) the environmental features that should be changed; and (3) outcomes that one would expect to improve as a result of changes in the built environment. They recommended elderly residents of long-term facilities and seriously ill children in acute or chronic health facilities as target populations who might especially benefit from environmental interventions. They further recommended that, in studies targeting chronically ill children, environmental features should be evaluated to determine whether the facility conveys the notion of a "special place" for children, whether the child and family feel a sense of control in the environment, and whether the environment promotes the family's role in helping a child cope.

Although built environment elements can affect both physiological and psychosocial function in children, little is known about the mechanism through which these effects take place. Lazarus and Folkman (1984) advanced the notion that an individual's perception or appraisal of a given situation, rather than an event itself, in part determines that person's experience of stress (and related health outcomes). Drawing on this idea and the findings from their literature review linking environmental satisfaction and perceived environmental control with affective outcomes, Sherman, Shepley, et al. (2005) proposed a conceptual model situating *perceived* built environment appraisal or satisfaction as a mediator between the *objective* built environment and health or health-related quality of life (HRQOL) outcomes. In other words, although this model posits an impact of the physical environment on health and HRQOL, it suggests that these effects may be at least partially affected by an individual's subjective appraisal of or satisfaction with that environment. This model may help explain why individuals respond differently, both physically and emotionally, to similar environments, and it suggests that evidence-based design may be a moving target. The use of

conceptual models to explain the relationship of the environment to health outcomes helps guide the development of research study designs around specific theory-driven hypotheses and the selection of appropriate variables to measure, and it may improve the ability to quantify the impact of the hospital built environment.

In addition to health-related and emotional outcomes, adult patients' satisfaction with their surroundings has also been significantly associated with greater satisfaction with general healthcare services (Pilpel, 1996; Verdeber & Reuman, 1987). Increasingly, perceptions of healthcare quality and satisfaction are studied as outcomes in a progressively more competitive healthcare marketplace (Varni et al., 2004). However, research is less common in the pediatric arena. Judkins (2003) documented the impact of the construction and design of a dedicated pediatric emergency department, demonstrating a significant increase in families' perceptions that the environment helped to reduce anxiety compared to prior ratings of families of children treated in a nonpediatric emergency department. In another study, Varni et al. (2004) found large, significant positive correlations between the satisfaction of patients' parents with the built environment and their satisfaction with healthcare services in a pediatric convalescent hospital for severely developmentally delayed children. The strong relationships Varni et al. identified between satisfaction with the built environment and satisfaction with healthcare services, coupled with the fact that the built environment under consideration was invariant, lent further support to the conceptual model in which *perception* of the built environment acts as a mediator between *objective* built environment features and both HRQOL outcomes and healthcare satisfaction.

Specific Aims and Hypotheses

The purpose of this study was to examine the relationship of the built environment to physical and emotional functioning in pediatric hematology-oncology patients and their parents. Healthcare satisfaction was also measured for parents. This study expanded on previous work in three essential ways: (1) operationalizing the latent constructs of the “built environment” and “built environment satisfaction;” (2) anchoring these constructs within a conceptual model that situates built environment satisfaction as a mediator between objective physical features and health, HRQOL, and healthcare satisfaction outcomes and that can be tested via a structural equation modeling (SEM) statistical procedure; and (3) obtaining child self-report (in addition to parent report) on measures of built environment satisfaction and physical and psychological functioning.

The overarching models for patients and parents are presented in Figures 1 and 2. The models begin with objective built environment features that were found in prior research and/or that are hypothesized in this study to be associated with health or satisfaction outcomes. For patients and parents, these include the stand-alone features of nature and room size in addition to an amalgamated built environment sum variable based on a checklist quantifying a number of environmental features. (For the full list of environmental features, see Table 1.)

The proposed mediator in the models is Built Environment Satisfaction, comprising satisfaction with the hospital room, perceived control over the hospital room, and satisfaction with the general environment of the hospital.

Outcome variables included Positive and Negative Affect, and Present Functioning for both children and parents. Healthcare Satisfaction (i.e., how satisfied parents were with the healthcare their children received) was also included as an outcome in the parent model.

As shown in Figures 1 and 2, a direct relationship was conceptualized between the *objective* built environment factor and all outcome variables for both patients and parents. The *perceived* built environment satisfaction factor was built into the model as a mediating variable (i.e., an intervening or linking variable) with a direct relationship between the Objective Built Environment factor and perceived Built Environment Satisfaction, and then between perceived Built Environment Satisfaction and all outcome variables.

Consistent with the proposed model (see Figures 1 and 2) and based on the empirical literature, it was hypothesized that:

1. For pediatric patients, more positive objective features of the built environment would be associated with better present functioning, greater positive affect, and lower negative affect.
2. For parents of pediatric patients, more positive objective features of the built environment would be associated with better present functioning, greater positive affect, lower negative affect, and greater healthcare satisfaction.
3. For both pediatric patients and parents, the relationships between antecedent variables (Objective Built Environment features) and the outcome variables (Present Functioning, Positive/Negative Affect, and Healthcare Satisfaction) would be mediated by satisfaction with the perceived built environment.

Method

Data were collected to address every part of the conceptual model (see Figures 1 and 2). Objective Built Environment features were quantified via a built environment checklist (see Table 1). Built Environment Satisfaction and all outcome measures were assessed via self-report questionnaires. All data collection procedures were approved by the institutional review boards of all participating institutions.

Participants

All patients who participated in the study had a hematology-oncology diagnosis, were inpatients at the time of their participation in the study, were at least 21 days post-diagnosis, were not in acute medical crisis at the time of participation, and could respond to questionnaires in English or Spanish. Participants were recruited from the main hematology-oncology unit as well as the rehabilitation unit in which hematology-oncology patients were routinely seen. Recruitment began with a charge nurse identifying patients who met study criteria. Study personnel approached the parents of these patients and the study was

described. If parents were willing, parental consent and child assent procedures were initiated.

Children were eligible to participate if they were between the ages of 5 and 18, but only data on 8–18 year olds are included in the analyses presented here because of differences in the questionnaire battery given to 5–7 year olds. Parents were eligible to participate if they had children who met study criteria who were between the ages of 2 and 18. In some cases, parents agreed to participate but their children chose not to participate or were not available at the time of questionnaire administration. Following consent/assent procedures, parents and children (ages 8–18) were given the assessment battery to complete, but they were also given the option to complete the questionnaires by means of interview.

Measures

Objective Environment

Built Environment Checklist—A Built Environment Checklist was used to assess patient rooms from which patients and parents were recruited. Because the study aimed to link the built environment in which patients and parents spent their time to their appraisal of the built environment, only patient room data were included in the patient and parent analyses; tracking patient/parent use of supplemental areas (e.g., playroom, kitchens) was not feasible for this study. A literature review and expert consultation (R. S. Ulrich, personal communication, 2003) revealed no gold standard instrument or methodology for evaluating Objective Built Environment features in pediatric hospital settings. The limited research using objective design features has been accomplished by either focusing on one feature (e.g., window view, as in Ulrich, 1984) or by generating checklists of features (e.g., Lawton, 1999).

Thus, the Built Environment Checklist used was methodologically exploratory and conceptually driven. It includes built environment features that, based on the literature review and expert consultation, have been identified as having potential health effects. Originally, the authors attempted to quantify the levels of controllability of features in addition to simply the presence or absence of features, but they could not establish adequate inter-rater reliability for the control measure. Instead they focused on readily quantifiable aspects of the environment. The Built Environment Sum aggregate variable was constructed by quantifying each environmental feature listed in Table 1. Each raw score was then converted into a z-score so that no feature would be weighted more heavily than any other simply on the basis of different rating scales. The z-scores were then summed to form the Built Environment Sum variable.

The Objective Built Environment latent variable utilized in the SEM analyses was composed of the Built Environment Sum aggregate variable in addition to room size (measured in square feet) and nature (a continuous variable scored 0–100 quantifying the percentage of view that was natural as opposed to urban or built in content). The room size and nature features were not included in the aggregate because these were each identified in prior research and by consultation as features strongly hypothesized to have a positive impact. As such, they were included as separate variables.

Subjective Environment

PedsQL Hospital Healing Environment Modules—The PedsQL Hospital Healing Environment Modules are based on the PedsQL Built Environment Modules (Varni et al., 2004) that were originally used to evaluate a convalescent hospital for developmentally disabled children. These demonstrated excellent internal consistency reliability validity but contained many questions that specifically pertained to the convalescent hospital population, and no child self-report instruments were created because the children in the convalescent hospital study were not capable of participation. Thus, the current questionnaires were developed to serve as more general environmental assessments and included child self-report. Instrument development utilized the PedsQL Measurement Model methodology (Varni et al., 2003; Varni, Burwinkle, Katz, Meeske, & Dickinson, 2002; Varni, Seid, Knight, Burwinkle, et al., 2002; Varni, Seid, Knight, Uzark, & Szer, 2002; Varni, Seid, & Kurtin, 2001; Varni, Seid, & Rode, 1999), which involves a literature review, focus interviews to identify pertinent domains of interest, module development, and pilot item testing through instrument completion and cognitive interviews; subjects report on their understanding of each question to ensure that an item is tapping the intended domain.

The parent report (of children ages 2–18) and pediatric patient report (ages 8–18) consist of three conceptually organized subscales: satisfaction with the built environment of the patient's room (18 items); satisfaction with control over the built environment of the patient's room (3 items); and satisfaction with the built environment of the overall hospital (21 items for parents, 18 items for children). The items for each form are essentially identical, with slight variations to accommodate developmentally appropriate language. For the Hospital Built Environment satisfaction subscale, the parent report asks about both the “kid-friendly” focus of decorations and activities as well as their age-appropriateness (items 4–7). These concepts were collapsed in the child form to “The way Children's Hospital is decorated for kids my age” (item 5) and “The things to do at Children's Hospital for kids my age” (item 6). Additionally, the parent form asks about the hospital layout and design (item 8); this was not found to be a meaningful concept during interviews with children.

The instructions ask, “How happy are you with...” each item. A five-point response scale is used, and a “not applicable” (N/A) answer could be selected. These instructions and scoring procedures were also used with the formerly validated PedsQL Built Environment Modules (Varni et al., 2004). Subscale scores were computed (if at least 50% of the items in that scale had been completed) by dividing the total for a given scale by the number of items completed for that scale. A total score could be generated in the same way (i.e., by dividing the total for the entire instruments by the number of completed items). In developing the PedsQL Hospital Healing Environment Modules, focus and cognitive interviews were conducted in both English and Spanish, resulting in the simultaneous development of both English and Spanish forms. No substantive differences in topic area were identified by this process, resulting in the same questions and content domains emerging in each language. The Spanish instrument was then translated and back-translated. For the sample in this study, alphas for both parent and patient (child) reports were adequate to excellent (.65 to .98; see Tables 2 and 3), indicating acceptable internal consistency for both English and Spanish forms.

Outcomes

PedsQL Present Functioning Scales—The PedsQL Present Functioning Scales (PFS) comprise six items that ask about anxiety, sadness, anger, worry, tiredness, and pain in the present moment (Sherman, Eisen, Burwinkle, & Varni, 2006). For the Child and Teen Self-Report there is an additional item assessing nausea. To answer each of the items, all versions of the PFS utilize visual analogue scales, 100-millimeter lines anchored at one end with a happy face and at the other end with a sad face. The instructions direct subjects to “Please put a mark on each line that best shows how you feel now.” The location of the mark is then measured in millimeters, thus generating a score between 0 and 100, with higher scores indicating greater dysfunction. The PFS Total Symptom Score is generated by calculating the mean of all scores. The Emotional Distress Summary Score is generated by calculating the mean of the anxiety, sadness, anger, and worry items. Adequate internal consistency was reported in a previous study (Sherman et al., 2006).

For this study sample, alpha scores for the full parent sample were adequate for the Total Symptom Score (.69), but low (.59) for the Emotional Distress Summary Score. Alphas for these scores were considerably higher for the English-speaking group than for the Spanish-speaking group (see Table 2). Interestingly, statistics demonstrated that the alpha discrepancy would disappear were the anger item to be removed, with new alphas ranging from .79 to .81 for both language groups, suggesting that the anger question may have functioned differently in the English and Spanish groups. The decision was made to retain the anger item to keep the construct equivalent across studies, but results should be interpreted with caution. For patient (child) self-report, alphas were in the acceptable range (.75–.80) for the total sample, with acceptable internal consistency for both English and Spanish groups (see Table 3).

Positive and Negative Affect (for Patients and Parents)—The Positive and Negative Affect Schedule (PANAS) is a 20-item (10 positive affect, 10 negative affect) self-report measure that addresses positive and negative affect as separate factors (Watson, Clark, & Tellegen, 1988). Positive affect includes such terms as *active*, *enthusiastic*, *excited*, *interested*, *proud*, and *strong*; negative affect is reflected in terms such as *afraid*, *distressed*, *guilty*, *irritable*, *nervous*, and *scared*. The directions ask about the extent to which one is experiencing each mood state “right now” and uses a five-point response scale (1 = *very slightly or not at all* to 5 = *extremely*). The PANAS has demonstrated good internal consistency, and its factorial stability has been established across samples (Mackinnon et al., 1999; Watson et al., 1988). The underlying factor structure of the PANAS has been replicated for the Spanish language version (Sandin et al., 1999). The PANAS-C for children (Laurent et al., 1999) has been used with children as young as third graders, though the factor structure has been shown to be more stable in children aged 10 and older (Crook, Beaver, & Bell, 1998; Kiernan, Laurent, Joiner, Catanzaro, & MacLachlan, 2001; Laurent et al., 1999). The underlying factor structure of the PANAS-C Spanish-language version has also been replicated (Kiernan et al.).

For both parents and patients, alphas (.82–.97; see Tables 2 and 3) demonstrated good internal consistency, with few differences between English and Spanish forms.

Healthcare Satisfaction (for Parents)—The PedsQL Healthcare Satisfaction Module (Varni et al., 2004) assesses parents' satisfaction with the healthcare their child is receiving. It comprises 24 items and six scales: (1) information (five items); (2) inclusion of family (four items); (3) communication (five items); (4) technical skills (three items); (5) emotional needs (four items); and (6) overall satisfaction (three items; e.g., “The overall care your child is receiving”). The instructions ask, “How happy are you” with each item. A five-point response scale is used, and scores are linearly transformed to a 0–100 scale, with higher scores indicating greater satisfaction, and computing scale scores when at least 50% of the scale items were completed. Internal consistency reliability has been previously established (Varni, Quiggins, & Ayala, 2000; Varni et al., 2004). In our sample, alphas (.82-.97; see Table 2 for all values) indicated good internal consistency and evidenced few differences between English and Spanish forms.

Statistical Analyses

Preliminary Analyses

Scale internal consistency reliabilities were determined by calculating Cronbach's coefficient alphas. Basic descriptives (means, standard deviations) were calculated for all measures.

The original intent had been to include all demographic variables as covariates in the structural equation models. Because of the large number of relationships involved relative to the comparatively small sample sizes, when the authors attempted to run the original models, their analyses failed to converge after 500 iterations, rendering the results uninterpretable. To enable testing of the central hypotheses (i.e., built environment satisfaction mediating the relationship between objective built environment features and outcome measures), and to maximize the ability to detect the existence of relationships between the main study variables (i.e., Objective Built Environment, Built Environment Satisfaction, and Outcome Measures), no covariates were included in the structural equation models, thus increasing the sample size to number-of-parameters ratio and therefore the ability to detect statistical relationships between core variables.

Structural Equation Model Analyses

Hypotheses 1–3 were tested by means of a structural equation model analytic approach using EQS software (Bentler, 1995).

Assessment of Model Fit—To test descriptive model fit, the root mean square error of approximation (RMSEA) (Browne & Cudeck, 1993) and the comparative fit index (CFI) (Bentler, 1990) were used. RMSEA values of less than .08 and CFI values greater than .93 are considered to be reasonable indicators of good fit (Thompson, 2000). After-model fit was determined, and factor loadings (relationship between observed variables and latent variables) and structure coefficients (relationship between latent variables) were evaluated for magnitude and significance.

Development of Latent Variables—In order to test the measurement model for each latent variable, factorial validity was assessed by determining whether individual measures

strongly indicated their target latent variable. Latent variables were developed and tested for Objective Built Environment (as indicated by nature, room size, and Built Environment Sum for room quality for patients and parents), Built Environment Satisfaction (as indicated by the three healing environment satisfaction subscales for patient and parents), Present Functioning (as indicated by current tiredness, pain, nausea, and the Emotional Distress Summary Score), and Healthcare Satisfaction (as indicated by the six Healthcare Satisfaction subscales). Latent variables were not specified for Positive and Negative Affect, because these were operationally defined by single measures.

Results

Pediatric Patient Results

Sample Characteristics—Of 175 parents/guardians of patients who were approached, 21 declined to participate or to allow their children to participate in the study. The most common reasons for declining included parents not wishing to have their child's medical records accessed and not wishing to take the time to complete the questionnaire battery. An additional 27 parents agreed to participate but their children were too young to participate (ages 2–4). Of the remaining 127 potential patients whose parents gave consent to participate, five were excluded from the analyses because they did not meet study eligibility criteria or had incomplete data or consent/assent paperwork, 18 were young children (ages 5–7) who completed an alternative questionnaire battery and were therefore not included in these analyses, and 14 children who were otherwise eligible did not participate for a variety of reasons (e.g., those who felt too ill or tired, though not in acute crisis, declined to participate).

The final group of patient participants consisted of a convenience sample of 90 inpatients in the hematology-oncology unit of a large children's hospital in Southern California (see Table 4). More boys than girls participated in the study, with a mean child age of 12.4 years. Consistent with national pediatric oncology statistics (National Cancer Institute, 2008), leukemia was the most prevalent diagnosis, followed by solid tumors. Patients in the study typically came from lower-middle-class families (Hollingshead, 1975). More than half of the patients who participated in the study were Latino, which is consistent with the patient population at the children's hospital in which the study was conducted. Patients who participated varied widely with respect to time since diagnosis and length of hospitalization.

Descriptive Statistics—Descriptive statistics for child self-report on all scales completed are presented in Table 5. Based on the absolute value of their scores, children reported a moderate level of Built Environment Satisfaction, with the highest satisfaction reported for the general Hospital Built Environment and the lowest satisfaction for Perceived Room Control. The Present Functioning Scales reflected relatively low levels of distress, with the highest score (indicating greater distress) for current tiredness. Children's scores reflect relatively low levels of Negative Affect and moderate levels of Positive Affect.

Structural Equation Model Analyses

Structural equation model analyses were undertaken to test the two hypotheses modeled in Figure 1: that a built environment with more positive objective features would be associated with better affect and present functioning outcomes (Hypothesis 1); and that the relationship between objective built environment features and affect/present functioning outcomes would be mediated by built environment satisfaction (Hypothesis 3). This model fit reasonably well descriptively ($\chi^2[46, n = 81] = 72.28, p < .01, CFI = .92, RMSEA = .09$). All standardized factor loadings were generally large and statistically significant for all three latent factors. For Objective Built Environment, values ranged from .57 to .91; for Built Environment Satisfaction, values ranged from .77 to .91; and for Present Functioning, values ranged from .42 to .84.

Hypothesis 1 was tested by creating direct paths from Objective Built Environment to Present Functioning, to Positive Affect, and to Negative Affect. As shown in Figure 3, none of these paths was significant, showing no direct relationship between Objective Built Environment features and Present Functioning or Affect.

The child component of Hypothesis 3 was tested by creating a path from Objective Built Environment to Built Environment Satisfaction, and a second series of paths from Built Environment Satisfaction to Present Functioning, to Positive Affect, and to Negative Affect. As shown in Figure 3, Hypothesis 3 was partially supported in that the direct path from Objective Built Environment to Built Environment Satisfaction was statistically significant ($\gamma = .27, p < .05$), indicating that children whose rooms had more “beneficial” objective built environment features were more satisfied with the built environment. The paths from Built Environment Satisfaction to Present Functioning, Positive Affect, and Negative Affect were nonsignificant, showing no direct relationship between Built Environment Satisfaction and Present Functioning or Affect. Thus the role of Built Environment Satisfaction as a mediator between these variables was not supported.

Parent Results

Sample Characteristics

As stated above, 175 parents/guardians were approached for study participation, 21 declined to participate, and five parents were excluded from the analyses for the reasons stated above. Our final dataset was therefore composed of the 149 parents whose information was included in the analyses (see Table 6).

Parents who participated were predominantly women. More parents of boys than girls participated in the study, with a mean child age of 9.67 years. Consistent with national pediatric oncology statistics, leukemia was the most prevalent diagnosis among the children of participating parents, followed by solid tumors (National Cancer Institute, 2008). Parents were typically of the lower-middle class (Hollingshead, 1975). More than half of the parents who participated in the study were Latino, which is consistent with the patient population at the children's hospital in which the study was conducted. Parents who participated in the study had children who varied widely with respect to time since diagnosis and length of hospitalization.

Descriptive Statistics

Descriptive statistics for the parent report on all scales completed are presented in Table 7. Based on the absolute value of their scores, parents' ratings reflected a moderate level of Built Environment Satisfaction, with highest satisfaction reported for the general Hospital Built Environment and almost equal ratings for Room Satisfaction and Perceived Room Control. Healthcare Satisfaction ratings were high, with a comparatively lower score on the Emotional Needs Subscale. The Present Functioning Scales reflected moderate levels of distress, with the highest score for current tiredness, and the lowest for current pain. Parent scores reflect relatively low levels of negative affect and moderate levels of positive affect.

Structural Equation Model Analyses

Structural equation model analyses were undertaken to test the two parental hypotheses modeled in Figure 2: that a built environment with more positive objective features would be associated with better Affect and Present Functioning outcomes as well as higher healthcare satisfaction (Hypothesis 2); and that the relationship between Objective Built Environment features and these outcomes (Positive/Negative Affect, Present Functioning, and Healthcare Satisfaction) would be mediated by Built Environment Satisfaction (Hypothesis 3). This model fit well descriptively ($\chi^2 [106, n = 123] = 179.44, p < .05, CFI = .94, RMSEA = .08$). All standardized factor loadings were generally large and statistically significant. For Objective Built Environment, values ranged from .63 to .91; for Built Environment Satisfaction, values ranged from .82 to .95; for Present Functioning, values ranged from .43 to .83; and for Healthcare Satisfaction, values ranged from .73 to .92.

The direct relationship between Objective Built Environment features and outcome measures posited in Hypothesis 2 was tested by creating direct paths from Objective Built Environment to Present Functioning, to Healthcare Satisfaction, to Positive Affect, and to Negative Affect. As shown in Figure 4, only the path between Objective Built Environment and Positive Affect was statistically significant ($\gamma = -.28, p < .05$), but in the opposite direction of what was hypothesized, indicating that more theoretically “beneficial” built environment features were associated with lower ratings of positive affect.

The mediational relationship proposed in Hypothesis 3 was tested by creating a path from Objective Built Environment to Built Environment Satisfaction, and a second series of paths from Built Environment Satisfaction to Present Functioning, to Healthcare Satisfaction, to Positive Affect, and to Negative Affect. As shown in Figure 4, the direct path from Objective Built Environment to Built Environment Satisfaction was statistically significant ($\gamma = .39, p < .05$), showing that parents whose rooms had more “beneficial” objective built environmental features were more satisfied with the built environment. The paths from Built Environment Satisfaction to Healthcare Satisfaction ($\gamma = .65, p < .05$), to Present Functioning ($\gamma = -.28$), and to Negative Affect ($\gamma = -.30$) were all significant ($ps < .05$). Thus, for parents, greater Built Environment Satisfaction was associated with greater Healthcare Satisfaction, better Parental Present Functioning, and less Parental Negative Affect, lending support to the mediational hypothesis. The path from Built Environment Satisfaction to Present Affect was not significant.

Discussion

Past research has shown a relationship between elements of hospital design and aspects of physical and psychological functioning in adult and pediatric patients. Studies on the hospital built environment have typically focused either on the variation of a single feature and an associated outcome, or they have considered built environment satisfaction as the outcome without considering actual health correlates. Guided by the conceptual model proposed by Sherman, Shepley, and Varni (2005), the purpose of this study was to learn whether, in a pediatric hematologyoncology unit, built environment satisfaction varied by exposure to different built environment features, and further to determine whether objective built environment features were directly associated with health outcomes. An additional goal was to determine whether *perceived* built environment satisfaction mediated the relationship between exposure to *objective* built environment features and a number of outcomes. These issues were investigated in two populations: pediatric hematology-oncology patients and their parents. Specifically, we investigated the relationships among objective built environment features, perceived built environment satisfaction, and physical and psychological functioning. Parental healthcare satisfaction was also evaluated.

The Relationship of the Built Environment and Built Environment Satisfaction to Outcomes

For this group of hematology-oncology patients, a significant positive relationship between built environment features and built environment satisfaction was revealed. Thus, although neither built environment features nor built environment satisfaction directly affected health outcomes in the children studied, our findings support the idea that pediatric patients respond differently to different hospital built environments. In other words, pediatric patients reported higher or lower levels of satisfaction with their built environment depending on the quality of the built environment in which they were placed.

Several factors may have contributed to the nonsignificance of the remaining paths in the children's mediational model. First, the analyses may have been underpowered because of the relatively small sample size. None of the samples in this study met the minimum sample size of 150 recommended for structural equation modeling analyses (Klem, 2000). However, descriptive model fit indices indicated relatively good fit and all of the standardized path coefficients that approached .3 were significant, suggesting adequate power. It is also possible that built environment satisfaction simply played no role in determining affect or present functioning in children. Given the relationships identified between the built environment and child functioning in hospital and more general built environments (Sherman, Shepley, et al., 2005), a third possibility for the present findings may lie in the context of the children's hospitalization. The demands of hospitalization (i.e., medical procedures, blood draws, side effects of therapy, and anxiety related to these processes) may have obscured the impact of built environment satisfaction on the physical or psychological functioning of these very sick children.

Although research in this new field (i.e., the impact of hospital design on pediatric patient functioning) has not yet established the magnitude-of-effect sizes that could be expected

from built environment manipulation, it is important to realize that we are likely looking for small effects. That effects may be small should not diminish their importance. The mean length of stay for children in this study was 17 days, with hospital stays extending for more than 100 days for some patients while under the persistent stress of their potentially life-threatening conditions. If built environment design can incrementally improve physical or emotional functioning in these patients, the benefit is well worth obtaining.

As with their children, parents' built environment satisfaction was also related to the objective built environment features to which they were exposed; greater satisfaction was associated with a higher number of built environment features hypothesized to be beneficial. Moreover, for parents, the mediational hypothesis was supported, such that the objective built environment was associated with built environment satisfaction, which in turn was associated with parents' satisfaction with the healthcare their child was receiving. Parents reported greater satisfaction with their child's treatment and medical providers when they were happier with their hospital rooms and other elements of hospital design.

Although the data collected here are cross-sectional and therefore no conclusions about causality can be made, these findings are consistent with the notion that improvements to the hospital built environment may be associated not only with enhanced built environment appraisal, but they may also contribute to parents' improved perceptions of their child's healthcare at a given institution-an important measure to consider in the increasingly competitive healthcare marketplace. These findings are consistent with previous results in a convalescent hospital environment (Varni et al., 2004).

Distinct from the child model, several factors were found to contribute to parental well-being. In further support of the mediational model, the paths from built environment satisfaction to both present functioning and negative affect emerged as significant. This suggests that parents who were more satisfied with their built environment also felt better physically and emotionally, and that making positive changes in the built environment could be associated with improved parental well-being. Given the distress experienced by parents of pediatric cancer patients reported in the literature (e.g., Sahler et al., 2002), these findings are particularly important when one considers the extensive time that these parents spend in patient rooms during their child's hospitalization.

Although parents in this study reported varying degrees of physical and emotional functioning, it is unlikely that many parents were as physiologically compromised as their children. Perhaps this difference in health status enabled the detection of the observed built environment satisfaction effect on functioning in parents but not their children. In other words, although the already compromised health of hospitalized hematology-oncology patients is vulnerable to the impact of countless variables from which it may be difficult to distinguish the effects of the built environment, it may be easier to detect a built environment impact on parents of more normal health status who nevertheless are subjected to vast amounts of time in the hospital built environment. It is also possible that the built environment effect on functioning was detected in parents but not children because of increased statistical power, given the greater number of parents who participated in the study.

In addition to the mediational relationships for parents described above, a path between objective built environment features and one of the outcomes of interest emerged as significant but in a direction opposite to that predicted. The presence of a greater number of built environment features hypothesized to be beneficial was associated with less positive affect. Whereas a complete presentation of secondary analyses of individual features is beyond the scope of this paper, the authors found that a small number of “beneficial” objective environment features (i.e., thermostat and bathroom on patient's side of room, and bathrooms with more features) were significantly and positively correlated with the number of pain medications prescribed to patients, and in the case of thermostat controls, with nurse rankings of severity of reason for hospitalization. Thus, the observed relationship between positive objective built environment features and lower ratings of parental positive affect may have been driven by variables related to their child's health status. In general, few systematic relationships were observed between patient health status and room features.

Limitations and Future Directions

As with any novel field of inquiry, identifying appropriate constructs for measurement, both in terms of built environment features and expected outcomes, is an iterative process that can be refined only by time and research. In addition, because of the incipient nature of this research, many of the instruments used had not yet been tested or validated. Although the results demonstrate adequate internal consistency reliability for most of the instruments in both English and Spanish, further research is necessary to establish the validity of these measures and to determine best practices for measuring both objective built environment and perceived built environment satisfaction.

Two additional problems may be associated with the instruments used in this study. First, although alpha scores were generally adequate for both child and parent measures, child self-report is typically found to be less reliable-though still important to obtain-than adult report. As such, the fact that responses to questionnaires resulted in the expected pattern of relationships that reached significance in adult participants, but not in children, may be an artifact of the self-report methodology utilized in this study. Second, the exclusive use of self-report questionnaires to measure the hypothesized mediator as well as all outcome measures may have contributed to inflating the relationships found between these constructs because of shared method variance. Future studies should consider the incorporation of an adult-proxy report for corroborative information on child functioning, as well as physiological indicators of stress.

Another limitation of this study was its cross-sectional design. Although structural equation modeling helps to elucidate complex relationships among many variables, causality can be established only via experimental design, so one cannot validly address the question of whether the outcomes were caused by antecedent variables. Possible designs that would bolster confidence in causality might involve assigning children randomly to rooms that vary by only one feature (e.g., natural vs. urban view; varying degrees of lighting control; full beds vs. single beds for parents; lightweight moveable furniture that allows for eating/playing together), or manipulating exposure to a feature across time (e.g., changing the artwork in a child's hospital room as in Eisen et al., 2008). Simulation studies may also help

elucidate the relationships between built environment features (e.g., room color) and pediatric patients' preferences and outcomes (Park, 2009).

As already mentioned, the hematology-oncology patients in this study were quite ill. As the science of the medical treatment of cancer and blood diseases continues to advance, so will the trend to hospitalize only the most critically ill children. The possibility of detecting an effect for the built environment necessarily dwindles under a myriad of physical and psychosocial confounding factors as the importance of providing an optimal built environment for healing increases. This challenge can be addressed by refining measurement instruments to identify the physiological and/or affective outcomes most likely to be responsive to built environment changes. Given that in this sample the children were able to report on their satisfaction, perhaps it would be appropriate for future studies simply to focus on increasing pediatric patients' satisfaction with their built environment.

The current study indicated only moderate levels of satisfaction with the least satisfaction associated with built environment control. These could be the targets of future interventions. Another possibility is to identify less seriously ill groups of children to learn more about the effect of the built environment, and then to apply these lessons to the built environments of sicker children and their families. Alternatively, simulation studies (e.g., Park, 2009) could be used to generate more specific built environment hypotheses that could then be tested in actual built environments. Hospital renovations are both expensive and infrequent. Increasing research on the effects of the hospital built environment to promote empirically supported hospital design is one way to ensure that these funds will be put to the best use.

Parents are important stakeholders in children's hospitals, both in terms of their children's healthcare as well as their own functioning within these built environments. Thus, it is important to consider not only the patient but parents and families as well when designing hospital built environments. Parents were an important part of this study, and there were clear relationships between built environment satisfaction and parental mood, satisfaction, and functioning. However, these models considered parent and child experiences independently of one another. A model that combines parent and child experiences will be richer and possibly allow for the identification of “trickle-down” built environment effects on child functioning from having better-adjusted parents. It should be noted that many children were not able to participate in our study because of age- or illness-related limitations, which compromised the capacity to explore the spectrum of parent-child built environment effects.

Because of the ubiquitous presence of families on hematology-oncology units, hospitals routinely include supplemental spaces on these floors, including kitchens, family rooms, laundry facilities, quiet rooms for napping, and playrooms for both patients and their healthy siblings. These areas could affect families' feelings of efficacy and control in caring for their child and help provide more homelike settings. In addition to such spaces, Child Life specialists are common on hematology-oncology units as well music therapists, teachers, and volunteers to help children and their families cope during hospitalization. Architectural design could promote or hinder their activities. This study did not address any supplemental

spaces, programs, or staff activities, but these are important areas that should be addressed in future research.

Likewise, for children, it is possible that the immediate distraction or entertainment in front of them in the form of an art project from Child Life, a musician, a pet therapist, or a video game is more salient than more permanent built environment fixtures (e.g., bathroom amenities, window view) and these should be incorporated into future studies.

Finally, as with any study, the generalizability of these findings is limited. This study sample was representative of the population of the hospital in which it was conducted, including its large Latino population. Similar research studies in other regions and with different populations are needed to determine whether these findings are representative cross-culturally.

Conclusions and Implications

To the researchers' knowledge, this is the first study of this scope to attempt an evaluation of a pediatric hospital built environment that incorporates both *objective* and *subjective* built environmental appraisals, measures of physical and psychological functioning, and pediatric patient self-report within the context of a priori models. It was determined that pediatric hematology-oncology patients and their parents report different levels of satisfaction corresponding to built environments of variable quality. For parents, appraisal of the built environment is associated with their physical and psychological functioning. Although clearly in its nascent stages, research suggests that improvements in the hospital built environment could enhance mood, functioning, and perceived quality of care in parents. It is hoped that by learning more about the hospital built environment and its function, the stress caused by poor design can be alleviated, and the capacity of hospital space to promote healing and well-being in all its inhabitants can be optimized.

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Figure 1.
Patient (child) model.

Figure 2.
Parent model.

Figure 3.
Patient (child) model with path values.

Figure 4.
Parent Model with Path Values.

Table 1

Built Environment Sum Features

Feature	Description of Feature	Scoring System
Window	Presence/absence of window on patient's side of room. If blinds did not open, rated "dysfunctional"	0 = no window
		1 = dysfunctional
		2 = window
Visitor Sleep	Type of bedding available for visitor (usually parent)	0 = no bedding
		1 = sleep chair
		2 = sleep bed
		3 = sleep chair and bed
Dimmer	Presence/absence of dimmer switch on side of the room. If dimmer did not work, rated "dysfunctional"	0 = no dimmer
		1 = dysfunctional
		2 = dimmer
Bathroom	Location of bathroom in relation to tide of the room	0 = other side
		1 = middle
		2 = same side
Bathroom Features	Amenities available in bathroom	0 = toilet only
		1 = toilet, shower
		2 = toilet, shower, tub
Sink	Location of sink in relation to patient's side of the room	0 = other side
		1 = middle
		2 = same side
Color Design	Presence/absence and location of colored designs	0 = no designs
		1 = wall or floor
		2 = wall and floor
Overhead Light	Location of controls for main overhead light in relation to side of the room	0 = other side
		1 = middle
		2 = same side
		3 = behind bed
Bed Light Control	Location of control for patient's bed light	0 = no control
		1 = cord behind bed
		2 = bed control
Bed Light Settings	Number of settings far bed light	0 to 3 settings
Television	Presence/absence of TV. If TV did not work, rated "dysfunctional"	0 = no TV
		1 = dysfunctional
		2 = TV
VCR	Presence/absence of VCR.	0 = no VCR

Feature	Description of Feature	Scoring System
	If VCR did network, rated “dysfunctional”	1 = dysfunctional 2 = VCR
Storage	Number of drawers and/or cabinets on side of room	0–3 storage units
Thermostat Control	Location of thermostat controls	0 = dysfunctional
	If control did not work, rated “dysfunctional”	1 = other side 2 = middle 3 = same
Booster Switch	Presence/absence of booster switch.	0 = no booster
	Location in relation to side of room	1 = other side 2 = middle 3 = same side

Table 2

Internal Consistency Reliability for Parent Report

n	No. of Items		Total Sample		English		Spanish	
	α	n	α	n	α	n	α	n
Healing Environment Scales								
Total environmental satisfaction	.42	71	.98	39	.95	32	.98	39
Room satisfaction	.18	93	.96	47	.92	46	.95	47
Room control satisfaction	.3	146	.83	85	.75	61	.75	85
Hospital environment satisfaction	.21	101	.96	61	.94	40	.97	61
Healthcare Satisfaction Scales								
Total healthcare satisfaction	.24	78	.97	45	.97	33	.96	45
Information scale	.5	143	.90	84	.91	59	.88	84
Inclusion of family scale	.4	140	.94	84	.95	56	.89	84
Communication scale	.5	140	.94	82	.94	58	.95	82
Technical skill scale	.3	130	.87	73	.88	57	.82	73
Emotional needs scale	.4	91	.94	53	.92	38	.94	53
Overall healthcare satisfaction	.3	146	.91	85	.92	61	.83	85
Present Functioning Scales								
Total symptom score	.6	148	.69	87	.82	61	.61	87
Emotional distress summary score	.4	148	.59	87	.81	61	.49	87
PANAS								
Positive affect scale	.10	138	.83	82	.82	56	.86	82
Negative affect scale	.10	138	.87	79	.87	59	.85	79

Table 3

Internal Consistency Reliability for Patient (Child) Report

n	No. of Items		Total Sample		English		Spanish	
	α	n	α	n	α	n	α	n
Healing Environment Scales								
Total environmental satisfaction	.39	41	.94	37	.93	4	.98	
Room satisfaction	.18	48	.90	43	.88	5	.98	
Room control satisfaction	.3	83	.66	75	.65	8	.74	
Hospital environment satisfaction	.18	66	.90	60	.90	6	.96	
Present Functioning Scales								
Total symptom score	.7	89	.80	81	.80	8	.77	
Emotional distress summary score	.4	89	.75	81	.76	8	.70	
PANAS-C								
Positive affect scale	.12	80	.91	72	.91	8	.97	
Negative affect scale	.15	79	.86	71	.86	8	.90	

Table 4

Patient (Child) Demographic Information

Demographic Variable	Range	Mean	SD
Age	8–17	12.40	2.78
SES	8–66	31.87	17.86
Time since diagnosis (days)	21–6,136	910.96	1275.73
Days hospitalized at time of recruitment	1–127	9.63	16.57
Total length of hospital stay (days)	1–227	19.36	31.95
		<i>n</i>	%
Gender	Male	52	57.8%
	Female	38	42.2%
Ethnicity	Latino/a	51	56.7%
	Caucasian	21	23.3%
	Asian	8	8.9%
	African American	4	4.4%
	Other/Missing	6	6.7%
Diagnosis	Leukemia	42	46.7%
	Solid tumors	26	28.9%
	Hematological	9	10.0%
	Neural tumor	8	8.9%
	Lymphoma	5	5.6%

Table 5

Scale Descriptive Statistics for Patient (Child) Self-Report

Scale	No. of Items	n	Mean	SD
Healing Environment Scales				
Total environmental satisfaction	39	88	63.81	17.50
Hospital room satisfaction	18	88	62.03	18.53
Hospital room control	3	85	54.17	26.70
Hospital environment satisfaction	18	88	67.14	18.91
Present Functioning Scales				
Total symptom score	7	90	20.23	16.95
Emotional distress summary score	4	90	17.53	17.38
Current tiredness	1	90	33.72	31.84
Current pain	1	90	17.31	22.90
Current nausea	1	90	18.49	24.30
PANAS-C				
Positive affect scale	12	89	2.60	.99
Negative affect scale	15	89	1.57	.60

Table 6

Parent-Report Demographic Information

Demographic Variable	Range	Mean	SD
Child's Age	2–17	9.67	4.53
SES	8–66	33.50	17.10
Time since child's diagnosis (days)	21–6136	689.59	1063.76
Days child hospitalized at time of recruitment	1–127	8.62	14.41
Total length of hospital stay (days)	1–227	17.33	26.95
		<i>n</i>	%
Parent/guardian gender	Male	27	18.1%
	Female	122	81.9%
Child's gender	Male	80	53.7%
	Female	69	46.3%
Ethnicity	Latino/a	91	61.1%
	Caucasian	31	20.8%
	Asian	11	7.4%
	African American	9	6.0%
	Other/Missing	7	4.7%
Child's diagnosis	Leukemia	72	48.3%
	Solid tumors	37	24.8%
	Hematological	10	6.7%
	Neural tumor	21	14.1%
	Lymphoma	8	5.4%
	Missing	1	.7%

Table 7

Scale Descriptives for Parent Self-Report

Scale	No. of Items	n	Mean	SD
<i>Healing Environment Scales</i>				
Total environmental satisfaction	42	148	66.35	22.91
Hospital room satisfaction	18	148	61.17	25.63
Hospital room control	3	147	61.99	29.65
Hospital environment satisfaction	21	147	71.82	22.03
<i>Healthcare Satisfaction Scales</i>				
Total healthcare satisfaction	24	146	82.73	20.05
Information	5	146	85.23	19.90
Inclusion of family	4	146	84.55	22.21
Communication	5	146	83.46	23.85
Technical skills	3	147	83.99	21.52
Emotional needs	4	137	71.90	29.03
Overall healthcare satisfaction	3	146	85.96	20.24
<i>Present Functioning Scales</i>				
Total symptom score	6	147	43.41	28.15
Emotional distress summary score	4	148	44.44	33.90
Current tiredness	1	147	56.05	34.14
Current pain	1	147	25.56	30.48
<i>PANAS</i>				
Positive affect scale	10	146	30.59	8.95
Negative affect scale	10	145	21.92	8.56