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A review of the literature in architecture and interior design revealed health benefits from exposure to natural conditions. This was not particularly surprising given work related to biophilic theory, which posits an innate human affiliation to nature. The positive effects of interaction with our environment were also found in literature related to child development which revealed the importance of nature and play for enriching children's development.

This project intended to quantify the variety of biophilic design attributes present within existing play spaces that are used to support children's health and well-being in healthcare settings within Child Life, a program that aims to help children and their families cope with the healthcare experience. The project used photography to document 24 inpatient play spaces in North Carolina health care facilities that employ Child Life. Features of the spaces identified in the photographs were then recorded using a Biophilic Interior Design Matrix, which was developed to inventory the range of biophilia design elements and their subset attributes (Kellert, 2008) to provide a quantitative score. It was developed and pre-tested in order to use the instrument to quantify the play room attributes and used inter-rater reliability testing to further define the instrument's accuracy and dependability. The results from the matrices was an average total biophilic attribute score of 21.5 out of 52 total points or a 41% average inclusion with a statistical range of 25 points. The average for all of the room's element sub-scores was averaged among each other with a 3.7 score of attribute inclusion per element among all of the play rooms. The element with the highest presence was Natural shapes and forms, the representation or simulation of the natural world, and the lowest was Place-based relationships, connecting culture

with ecology and the geographical context. These results offer initial findings as to what levels the biophilia attributes are found in the interior, and specifically in Child Life play spaces.

An online survey of the eight Child Life facilities staff was conducted regarding their play space preferences, where they use these rooms to work with hospitalized children. The four open-ended question's responses showed the most common topic was a desire for a spacious environment with 54% of play rooms either requesting more space or appreciating a large space. The human desire for spaciousness was found to be greatly desired in interior play rooms for its ability to help patients move throughout the space easily and have access to choices of activities alongside other patients. Secondly, around 30% specifically wanted or appreciated having various nature-based design features. Also, the surveys resounded with support for the play space as a tool used by Child Life in its endeavors for supporting their pediatric patients and its effectiveness.

The survey results were incorporated with the matrix findings to create 24 case studies of the play spaces. The lowest effectiveness ratings from the survey responses were found in spaces scoring on the lowest end of the matrix results and further support a link between an environment with a higher variety of biophilic attributes and an effective Child Life play space. These case studies showed that biophilic features were found in varying amounts and some were specifically indicated as being desirable. Further research on the individual attributes and wider application of the matrix may add to this initial quantification of biophilia. The matrix is easily adapted for additional applications and was aimed at assisting interior designers with aiding biophilia identification and incorporation. The case studies provide support for future biophilia design decisions, as well as informing additional research involving Child Life play spaces.

AN INVENTORY OF BIOPHILIC DESIGN ATTRIBUTES WITHIN CHILD LIFE

PLAY SPACES

by

Beth L. McGee

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Approved by

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CHAPTER I

INTRODUCTION

This research focused on the presence of biophilic design attributes in inpatient

healthcare play settings. In its original definition by E.O. Wilson (1984) biophilia is described as

"the innate tendency to focus on life and lifelike processes" (p. 1). This reference to "life"

extends to an inherent affinity of human beings for nature (occurrences requiring no or little

human intervention) or its representation and is further recognized as a "biologically based need

integral to our development as individuals" (Louv, 2008, p. 43). This need is linked to our

emotional, cognitive, aesthetic, and spiritual development (Kellert, 1993). In subsequent

research, investigators revealed that the developmental health of children is improved when they

were able to play in biophilic environments (Kahn & Kellert, 2002; Kellert, 2005, 2008; Louv,

2008). Given this, Child Life therapeutic interventions, which utilize play for the support of

hospitalized children, may be more successful in physical environments that include biophilic

designs. With the need to further define biophilic design, Stephen Kellert proposed

categorization of more than seventy biophilic design attributes within six biophilic elements:

environmental features, natural shapes and forms, natural patterns and processes, light and space,

place-based relationships, and evolved human-nature relationships (2008).

Child Life is a professional healthcare field that works with pediatric patients to promote

effective coping from stress "through play, self-expression activities, and age-appropriate medical

preparation and education" ("Child Life Council: The Child Life profession," n.d., p. 1). The

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American Academy of Pediatrics affirms that Child Life services are essential to quality pediatric health care and are important for family-centered care and best-practice health care models (Child Life Council & Committee on Hospital Care, 2006). Child Life services, including access to the therapeutic benefits of play, are often utilized bedside or in Child Life play spaces.

The research questions for this project are: How is biophilia represented in interior spaces and how can you measure a biophilic presence; as well as what environmental perception Child Life Specialists have regarding their current play spaces? Using Kellert's elements and attributes to find the variety of biophilia present provided a way to assess the primary purpose of this study, which was to assess the variety of biophilic design attributes present in Child Life play spaces in North Carolina inpatient healthcare settings. The secondary purpose was to determine the perceptions of the play space's design by the experts of those spaces, the Child Life Specialists, and this was facilitated through a survey of the Specialists.

Beginning with Roger Ulrich's fundamental work in 1984, designers began seeking evidence-based research for making design decisions, which included researching the incorporation of nature within healthcare settings. Meanwhile, Child Life was also growing as a defined occupation and broadening its research-based acceptance within healthcare. The Child Life play space has been gaining prominent attention in facilities and serving a vital function for patients trying to normalize their lives through play while hospitalized.

This project used a mixed method study with two instruments developed to address the two research goals. The primary instrument assisted with measuring the variety of biophilic design attributes present in Child Life play spaces. The selection of Child Life play rooms was

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due to its definable parameter and the importance of these spaces. For this purpose, North Carolina health care facilities that employ Child Life inpatient play spaces were visited and photographed. Photography of the sites was used to assist with quantifying the attributes and included 24 out of 27 play spaces in the State. The Biophilic Interior Design Matrix instrument was created for this research to process the information in the photographs and was developed with six categories of biophilic design elements and 54 sub-categories of design attributes based upon Kellert's (2008) research. The identification of the item in the space was based upon the attribute's definition. The identified biophilic features were then documented in the matrix, which produced sub-scores and total scores of each element and attribute for each space. These scores revealed that the variety of attributes present varied in quantity among the spaces and it was found that multiple attributes were fairly commonly used while some were hardly ever present. Additionally, some design features were found to have multiple attributes.

The second purpose of this research was finding out the perceptions of the Child Life Specialists regarding their play spaces and if they viewed biophilic features as preferred features in their spaces. This was addressed using a survey with four open-ended questions. The responses showed a high level of support for having or a desire for a spacious environment and around 30% specifically stated they wanted or appreciated having nature-based design features. The surveys resounded with support for the play space as a tool used by Child Life in its endeavors for supporting their pediatric patients.

These qualitative survey responses were analyzed with the quantitative findings of the matrices to inform the development of case studies for each play space. The outcome was 24 case studies representing North Carolina Child Life play spaces. These case studies showed a

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link between the environment and the perceived effectiveness of the spaces, with biophilic attributes found in features perceived as supporting effectiveness. The highest scoring space showed the most positive expressions about the design features, which included a wide variety of biophilic attributes. The lowest scoring space was one of the smallest rooms, had no access to daylight, and did not have as dominant of a representational design theme as most of the other spaces.

Further research on the individual attributes and wider application of the matrix scoring to indicate greater trends and research possibilities will continue to add to this initial quantification of biophilia, as well as the further need to find more research-based evidence for incorporating biophilia into play rooms and other interiors. Future research regarding each attribute and how or when it is best to use them is needed. The development and testing of multiple attribute supporting design features could also provide helpful insight into the benefits of biophilia and how best to maximize the use of it in the interior. The matrix is also easily modified for additional applications for other spaces and was aimed at assisting interior designers with identifying biophilia in other interior spaces and aiding the incorporation of biophilic design. The case studies may inform future design decisions, as well as prompting additional research involving Child Life play spaces for the betterment of the pediatric patients and staff that use these play spaces.

CHAPTER II

LITERATURE REVIEW

E.O. Wilson's definition of biophilia is "the innate tendency to focus on life and lifelike

processes" (E. Wilson, 1984, p. 1). This definition was expanded upon by Stephen Kellert and

colleagues (Kellert, 2008) to encompass learning, experience, and sociocultural support that

affect the relationships between people and natural environments. The biophilic response is often

present unconsciously in our cognition, emotions, art, and ethics (Kahn, 1997). Wilson writes

that biophilia is seen in the responses of "the predictable fantasies and responses of individuals

from early childhood onward. It cascades into repetitive patterns of culture across most or all

societies, a consistency often noted in the literature of anthropology" (1984, p. 85). This vast

presence of biophilia throughout the world and throughout the human life span includes

childhood; however the need for interaction with nature in modern society as people are more

sequestered inside the built environment has reduced the human-nature interaction. This

separation from nature has also applied to children. Louv (2008) believes nature interaction is

necessary to foster a biophilic realization early in childhood that assures healthy lifelong

development and the separation from it in any stage of development can lead to a *nature-deficit*

disorder, which are negative physical, emotional, and psychological symptoms from a separation

from nature. Hospitalization further precludes or prevents interaction with nature. The Child

Life play room is one of the rooms pediatric patients spend the most time in outside of their own

patient rooms; thus, the play room provides a unique environment for supporting the work of both

Child Life and biophilic interactions. This literature review discusses both Child Life and

biophilia, and begins with a further elaboration of biophilia.

Biophilia

An overarching theoretical support for this research is found in biophilia, the human

biological need for a connection to nature and its representations (E. Wilson, 1984). This innate

need for contact with nature remains nascent and will atrophy without exposure to complex

stimulation from nature-based interactions. Wilson describes biophilia as a complex of learning

rules rather than a single instinct and can range from attraction to aversion (1993). The rules are

stimulations found in our contact with nature or natural representations and encompass physical,

psychological, and cognitive benefits. Biophilic design research emanated from Roger Ulrich's

pivotal work in which he demonstrated the link between nature and health. His 1984 study

showed an increase in the healing rate of surgery patients who were exposed to a view of nature

with a corresponding decrease in pain medication needed during their recovery from surgery, as

well as a reduction in nurses' notes regarding negative patient behaviors. Ulrich's 1984 study

influenced many disciplines of research and was the beginning for evidence-based design, which

bases design decisions upon research in order to achieve the best outcomes ("History of EBD,"

n.d.). This study was combined with research support from, and expanded the importance of,

Moore's (1981) study regarding Michigan prisons. Moore recorded 24 % more illness in inmates

whose cells faced the prison courtyard than in those with a view of farmland. Ulrich's own 1979

study also provided preliminary support for his 1984 study when he showed health benefits from

nature where lightly stressed individuals viewing images of natural landscapes had modified

emotional states that increased *positive affect* over those who viewed images of urban settings.

Specifically, those viewing natural scenes experienced higher levels of affection, friendliness, playfulness, and elation, with lower levels of fear, arousal, and sadness. This supported the nature and health link that was further developed in his 1984 study.

The idea that nature is healthful goes back to antiquity and is expressed in many cultures (Ulrich, 1979). Additional research that built upon the earlier research findings of the 1980's provided further support for the benefits of nature for humans. Ulrich and colleagues (1991), for example, demonstrated a psychological influence in 120 subjects who first viewed a stressful movie but then were exposed to color/sound videotapes of natural or urban settings. The findings showed faster and more complete physiological recovery from the stressful movie when exposed to the natural environment. Findings such as these indicate that the "restorative influences of nature involve a shift toward a more positively-toned emotional state, positive changes in physiological activity levels, and that these changes are accompanied by sustained attention/intake" (p. 201). In another study of a workplace environment, Leather, Pyrgas, Beale, and Lawrence (1998) found a positive effect from sunlight on job satisfaction and employee general well-being. Further, their research revealed that a view of natural elements such as trees, vegetation, and plants buffered the negative impacts that job stress had on intentions to quit, thus affecting most areas of human life including physiology, psychology, and social life.

The power of nature to increase enjoyment, relaxation, and lowered stress has been found in various types of nature based interactions, such as pet ownership and gardening. Therapies such as horticultural therapy and pet therapy have been widely accepted in healthcare as providing beneficial treatment outcomes. The benefits of gardening were seen as early as the 1870's when mental illness in the U.S. was treated with gardening or working the soil (Yanni,

2003). In the 1950's a wider appreciation for active interaction recognized therapeutic benefits

for those with chronic illness, and many horticultural therapy programs were formed in colleges

and universities that worked actively with nature (Louv, 2008). Another study of elderly

residents in a residential care facility found lower stress hormone levels after using an outdoor

horticultural garden for completing the same activities as those who used an indoor classroom

(Rodiek, 2002). Another study of elderly residents showed positive changes in their diastolic

blood pressure, overall leisure satisfaction, and relaxation states after adding an aquarium as an

interactive hobby (Riddick, 1985). In a study of heart disease supporting the use of pets for

health, patients confirmed pet ownership can aid in survival among patients with coronary artery

disease (Headey, 1999). These studies are examples of the interdisciplinary body of evidence

which shows that interaction with nature can influence positively the reduction of stress,

improvement of emotional well-being, and alleviation of pain (Kellert, 2008). After a review of

literature, the Kaplans (1989) conclude that:

> The immediate outcomes of contacts with nearby nature include enjoyment, relaxation,
> and lowered stress levels. In addition, the research results indicate that physical well-
> being is affected by such contacts. People with access to nearby natural settings have
> been found to be healthier than other individuals. The longer-term, indirect impacts also
> include increased levels of satisfaction with one's home, one's job, and with life in
> general (p. 173).

With the evidence-based research supporting nature for promoting health, the question remains

how to identify it or its representations within the interior environment. Looking at Stephen

Kellert's (2008) biophilia categorization provides an organization for assessing biophilia.

The categorization of biophilia begins with two types of interaction styles, which creates a distinction between *passive* and *active* interaction. *Active* interaction is an immersive experience such as hiking in the woods or the actual caring for a plant. Gardening is an example of active interaction with proven benefits (Louv, 2008).

When *active* interaction is not available, people create an artificial contact with nature or *passive* interaction, which is simply observing nature or a singular natural element without direct interaction with it. Heerwagen and Orians (1986) looked at how office employees decorated their space in relation to their access to a natural view. They found that the employees with windowless offices used more landscape surrogate visual materials vs. cityscapes when compared to windowed offices. The indoor preference for a natural view compared to a man-made view further supports the biophilia hypothesis and *passive* interaction, where not having direct contact with nature, while passive, still nourishes the need for contact with nature (Bates & Marquit, 2010). Examples of this interaction include looking out of a window or viewing a digital image of a natural view. Being in a space with a natural element such as a waterfall or houseplant and not having direct contact is also *passive* interaction. Research on *passive* nature therapy includes Ulrich's (1984) study showing the benefit of a window view of a natural setting compared to those with windows facing a brick building wall. In a separate study, Ulrich (1981) found that water, and to a lesser extent views of vegetation, had more positive influences on psychophysical states and nature, especially water, had more positive influences on emotion states. Nature views were more effective at holding attention than urban views. *Passive* interaction's ability to influence people is important for interior design application, as it provides the built environment a

bigger bridge to the benefits found in nature interaction that would otherwise be excluded if only

active interaction were needed. These interactions provide a background for Kellert's biophilia

dimension, elements, and attributes categorizations that will be used for quantifying biophilia in

this project. These include seventy-two attributes that are categorized under six elements, and

into two main dimensions.

Biophilia Dimensions

Kellert proposed two dimensions of biophilia that form an umbrella for the other

classifications of elements and attributes to reside under. The two main dimensions are the

categories of *organic or naturalistic* and *place-based*.

The *organic or naturalistic dimension* defines shapes and forms in the built environment

to be reflective of the bond that people have for nature either *directly*, *indirectly*, or *symbolically*.

Kellert (2008) explains that this *organic* dimension is considered *direct* when the human bond

involves something that is unstructured or is considered self-sustaining. This includes such things

as daylight, plants, animals, natural habitats, and ecosystems that do not require human

intervention. Examples of research supporting the inclusion of direct contact with nature includes

studies that have established a positive correlation between children's direct nature exposure and

the reduction of ADHD symptoms (Faber Taylor, Kuo, & Sullivan, 2001; Kuo & Taylor, 2004;

Pellow, Solomon, & Barnard, 2011). *Direct* bonds are needed and preferred for development,

and can be *active* or *passive*. Bonding with the woods while climbing trees is *direct* and *active;*

sitting alone in the woods is *direct* and *passive*. Similarly, sitting in sunlight that is streaming

into the interior is a *direct* experience. The *direct* bond is the most "wild" aspect of nature and

has the greatest research base for supporting biophilia and includes the interior applicable feature

of daylight. Research examples regarding daylight include a study showing that daylight exposure can positively influence job burnout (Alimoglu & Donmez, 2005). Further, the presence of daylight has been linked to increased job satisfaction, to controlling the body's circadian rhythms, and aids in a number of other diverse healthcare outcomes (Joseph, 2006).

The interior offers greater opportunity for *indirect* and *representational* incorporation. *Indirect* contact with nature is something that requires ongoing human input to survive, such as a potted plant, water fountain, or aquarium. This is considered an *active* interaction when an aquarium, for example, is being interacted with through feeding and maintenance and *passive* if only being viewed. One example of research support for indirect interaction includes a study regarding the physiological consequences of nature therapy on relaxation that studied the influence of an aquarium compared to hypnosis for relaxing. The results demonstrated that the aquarium was equal to the hypnosis for relaxation benefit (Katcher, Segal, & Beck, 1984) and further demonstrates the physical affect *indirect* contact with nature can have on people even if only a *passive interaction*. Additionally, a *symbolic* contact involves the use of representations of nature and can be seen in examples like the use of videos, photographs, and images, which are all considered *passive* forms of interaction. This is a very common form of interior nature inclusion and prompted several studies by Ulrich. One of his studies showed that exposure to nature was beneficial even when viewing images of nature in photos or videos (Ulrich et al., 1991). Ulrich's (1979) research on students experiencing final exam stress compared viewing nature scenes versus city views without nature, i.e. vegetation. Using self-ratings, the students assessed their recovery after viewing slides of either everyday nature scenes or unblighted city views which lacked vegetation and showed the benefits of exposure to nature scenes. The nature-based scenes

increased feelings of affection, friendliness, playfulness, and elation. The urban scenes however

worked against the emotional wellbeing and increased the feelings of sadness, and even anger and

aggression. In another study of Ulrich's in Sweden (1981), the subjects' emotional states were

more positive and mental attention more effective after viewing natural scenes as opposed to

urban scenes. The verbal results were consistent with brain electrical activity suggesting that

individuals experienced more positive influences on well-being when viewing natural scenes

versus urban scenes. Supporting these finding, two studies about nature's representational use

revealed that natural environments produced more positive emotional responses than urban

scenes and the representational natural scenes all showed marked beneficial influence on the

viewers(Hartig, BööK, Garvill, Olsson, & GäRling, 1996).

Additional examples of representational incorporation of nature include the imitation of

natural processes which can be seen in fractal designs. Contact with nature, even with

representational complex geometry representing natural forms, is beneficial (Kellert, 2008). A

fractal is a nature-based complex shape with non-Euclidean geometry that is self-similar. Natural

object examples include seashores, snowflakes, cauliflower, and mountain ranges. Salangaros

and Masden (2008) argue that built environments with fractal features are neurologically

nourishing, because they reconnect people with biologically preferred environments. "Human

beings connect physiologically and psychologically to structures embodying organized

complexity more strongly than to environments that are either too plain, or present disorganized

complexity" (Kellert, 2008, p. 63). Research by R. P. Taylor (2006) based on earlier NASA

studies explored the fractal dimension preference. Taylor found that cultural background and

gender did not significantly influence the fractal preference value. Adaption of how to use the

fractal is another consideration. A study on visually complex skylines found that the strongest

influence for preference, arousal, and pleasure was the skyline silhouette or the irregular outline

of the objects that are fractal in nature (Heath, Smith, & Lim, 2000). The importance of the

fractal design element is not its literal naturalness but the symbolic reflection of natural occurring

patterns, a nature-based representation.

The *organic or naturalistic dimension* with its range of research support is complemented

by the second dimension, which is *place-based or vernacular*. Buildings and landscapes are

connections to our culture, as well as the ecology and geology of a region. This is often defined

as a sense of place or how you experience a particular space and results in looking at architecture

as the combination of human and environment. Design with this focus uses a mixture of physical,

social, and personal features to create a supportive environment (Steele, 1981). This is how

buildings can become part of the individual and the collective social identity. Together with the

organic dimension, these two main biophilic categories are further divided into six biophilic

design elements. These elements provide the specific framework that this research used for its

biophilia identification.

Biophilia Design Elements

Hildebrand (2008) postulated that biophilic architectural space can be seen through

identifying the characteristics of nature in a space. Also, the elements of biophilia as a design

tool provides useful advantages for architectural designs over other more theoretical bases

because it can be grounded in both empirical and theoretical work relative to the fields. When

using Kellert's (2008) attributes, fifty-four out of seventy-two of them were applicable to interior

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architecture in Child Life play spaces. See Appendix E for further definitions and the complete

listing of Kellert's elements and attributes. Each element with Kellert's description follows, as

well as a listing of the attributes used in this study.

Environmental features

Kellert's description of the *Environmental features* element reads: "The first and most

obvious of the biophilic design elements is environmental features, involving the use of relatively

well-recognized characteristics of the natural world in the built environment"(2008, p. 6). These

features include: color, water, air, plants, animals, natural materials, and fire. These attributes are

influential or necessary for people to survive. This is categorized as part of the *organic*

dimension which has the three choices: *direct*, *indirect*, and *symbolic*. *Direct* or "wild" nature is

not often brought into the interior, except in the use of daylight as seen in the *Light and space*

element, but *indirect* attributes are also found under this element and are the natural occurring

items. The indirect and human controlled attributes in this element are water, air, plants, animals,

and fire. When looking at *indirect* and *symbolic* attributes, examples of the two dimension

choices would be a water fountain, which is an *indirect* choice as it is human controlled in the

interior environment, and a picture of a fountain, a *symbolic* choice. The interaction styles will

only be discussed in this element, where it offers the only *active* interaction possibility with the

caring for plants, water features, animals, and fire. *Passive* interaction in children's play spaces is

the most common and in this element can include the presence of color, water (such as an

aquarium, sink, water fountains, etc.), natural ventilation through operable windows and doors,

live plants and animals, that are viewed but not maintained by the children, natural materials, and

fire.

Natural shapes and forms

The second element is *Natural shapes and forms*. "This element includes representations and simulations of the natural world often found on building facades and within interiors" (Kellert, 2008, p. 8). These shapes and forms are: botanical motifs; tree and columnar supports; animal (vertebrate); shells and spirals (invertebrates); egg, oval, and tubular forms; arches, vaults, and domes; shapes resisting straight lines; simulation of natural features/biomorphy; geomorphy; and biomimicry. This can be found in the *symbolic* and *passive* incorporation of the design elements, with an example seen in Figure 1. This figure shows a facility that used both symbolic tree-like supports and tubular forms in the creation of the roof support structure. These supports are also biomorphic, representative of nature, in their tree-like design.

Figure 1. Image of the interior of Stuttgart Airport. Image shown is between Terminal 1 and 3 and was taken on 2005-06-02 by James Bowes and seen at http://en.wikipedia.org/wiki/File:Stuttgart_Airport_Interior_2005-06-02.jpg#filelinks.

This element differs from the first element in that it only looks at representational (*symbolic*) incorporation, such as the tree and columnar supports (as seen in this figure with its tree-like structure). A few unique attributes in this element include the *simulation of natural features* and *biomorphy;* both seek to imitate the forms of nature. These two attributes are so

similar that they were combined into one attribute. *Biomimicry* looks to nature as a model for design decisions. The attribute *geomorphy* replicates or mimics nearby geology, stratified surfaces, or landscaping adjacent to the site and is another example of how biophilia can be found when a natural feature of nearby nature is brought into the interior environment.

Natural patterns and processes

The third element is *Natural patterns and processes*. "This element emphasizes the incorporation of properties found in nature into the built environment, rather than the representations or simulations of environmental shapes and forms" (Kellert, 2008, p. 9). These patterns and processes are properties found in nature and include: sensory variability/ information richness; age, change, and the patina of time; central focal point; patterned wholes; bounded spaces; transitional spaces; linked series and chains of spaces; integrations of parts to wholes; complementary contrasts; dynamic balance and tension; fractals; hierarchically organized ratios and scale. This element is another dominantly *symbolic* and *passive* design element. The sensual, visual, and spatial information present allows for opportunities to include items such as fractals, which are symbolic in their natural representation. *Fractals* are shapes that have organized complexity and "human beings connect physiologically and psychologically to structures embodying organized complexity more strongly than to environments that are either too plain, or present disorganized complexity" (Kellert, 2008, p. 63). The varieties of mathematic proportion and repetition, information, patterns, and spatial connections found in this element add connections to natural occurring patterns in the interior environment.

Light and space

The fourth element is *Light and space*. This element includes "twelve design attributes… [with] seven focusing on qualities of light and five focusing on spatial relationships" (Kellert, 2008, p. 11). The attributes are: natural light, filtered and diffused light, light and shadow, reflected light, light pools, warm light, light as shape and form, spaciousness, spatial variability, space as shape and form, spatial harmony, and inside-outside spaces. The first attribute, *natural light,* is a *direct* attribute*,* which means natural day light is not supported by man and is a natural occurrence that can be brought into the interior. Filtered lighting is *indirect* as it is day light modified by man. Research on day light includes a study that involved exposure to the seasonal patterns of day light and found that it influenced hormone levels and positively impacted the ability to concentrate, co-operate, and resist sicknesses (Küller & Lindsten, 1992). Additionally, differentiation of light, mass, and/or scale in a room can foster emotional and intellectual stimulation. The use of *Light and space* can be seen in Figure 2 where the use of light as shape and form is seen in the accent lighting that runs around the edge of the soffit creating a defined shape, as well as the fiber optic lighting in the middle that further defines the space. The variety in the height of the space adds spatial variability and when including the use of fiber optics helps to create a spatial harmonic sense of being under the cover of a night sky viewing a star field.

Figure 2. Mattel Children's Hospital at UCLA Child Life Play Room. Photo credit http://www.uclahealth.org/virtualtours/reagan/tourfiles/flash/index.html.

Place-based relationships

The fifth element is *Place-based relationships* and "refers to the successful marriage of culture with ecology in a geographical context. The connection of people to places reflects an inherent human need to establish territorial control…. Locational familiarity—the yearning for home—remains a deeply held need for most people" (Kellert, 2008, p. 12). Culture with ecology in a geographic setting includes: geographic connection to place, historic connection to place, ecological connection to place, cultural connection to place, indigenous materials, and landscape orientation/ landscape features that define building form. These attributes add to creating a connection to the locality of a place and support the unique sense of place that occurs when the interior connects with the greater environment. The physical, emotional, and psychological sensation and memories of being in a specific location can occur when some of these features are present in the space. The landscape orientation of a building and the features found in the landscape were combined into one attribute as they provide a similar outcome in interior design, which is an influence of the outside landscape on the interior space. The overall importance of

this element, *Place-based relationships,* is that it connects the interior with its surroundings and adds another unique type of nature connection.

Human-nature relationships

The sixth and final element is *Human-nature relationships*. "The term is somewhat misleading, as all the described biophilic design elements presumably reflect biologically based human affinities for the natural environment. The attributes described in this section, however, more specifically focus on fundamental aspects of the inherent human relationship to nature" (Kellert, 2008, p. 13). Labeled as evolved human-nature relationships by Kellert, this was simplified to human-nature relationships to broaden the research support basis beyond purely evolutionary theory. The attributes include: prospect and refuge, order and complexity, curiosity and enticement, and change and metamorphosis. Each of these individual attributes are a combination of two aspects of the environment that when combined create a unique attribute. *Prospect and refuge* provides protection while also offering permeable boundaries for providing the prospect view of the surrounding area (Kahn & Kellert, 2002). With *order and complexity*, too much complexity results in chaos and order alone is monotony, so complexity needs to be paired with order. It is just like complexly ordered sound is called music, but chaotically complex sound is called noise. Similarly, we distinguish buildings by the evident order and complexity of the materials and design features used, for example the use of multiple columns on a façade. In *curiosity and enticement*, curiosity is the need for exploration and creativity. Enticement draws our interest outward and into action. Paired together they can exercise imagination and creativity through using layers of details and variety to draw out interest. The movement from darkness to brightness within a building is enticing, for example. A sensually

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diverse environment can draw out curiosity. *Change and metamorphosis* is present in growth,

maturation, and metamorphosis, and can be seen in the flow from one form or state to another.

The sands on the seashore are an example of never ending change.

St. Louis Children's Hospital offers activities in their sibling waiting room for children

up to the age of eleven that use many of the *human-nature* relationship element's biophilic design

attributes, see Figure 3.

Figure 3. St. Louis Children's Hospital Play Room. This recreational play room is intended for the siblings of hospital patients 2 to eleven years old. A virtual tour of the space can be found at http://www.stlouischildrens.org/content/virtualtours.htm under the Sibling Play Area icon. Photo credit-http://www.stlouischildrens.org/content/SiblingPlay room.html.

Prospect and refuge are found in the central focal point tower that has a lookout platform above

and provides prospect views of the play room. The small enclosure underneath provides refuge.

Order and complexity is apparent in the complex color and patterns used, while order is found in

the use of closed and open storage that houses activities and toys in an organized manner. The

use of color is also used to define zones and provide a sense of bounded space, increasing order.

These features of order and complexity are more harmonious when used together. *Curiosity and*

enticement is found in the layout of the room that does not allow a complete view of the entire

space upon initial glance prompting movement through the space, while the available play

options and layers of detail foster imagination for what fun can be had. If *change and metamorphosis* were present it could be in the use of wood features that patina and change over time and the use of colored lighting that could morph throughout the day from one color to another. All together all of these biophilic elements and attributes can help us view the interior environment through a lens targeted to identify biophilic presence within children's play spaces. Each of the attributes and elements that were used in this research are listed in Table 1.

Table 1. Interior biophilic elements and attributes of design, based on S. Kellert (2008).

Environmental features	Natural-shapes and forms	Natural patterns and processes
Color	Botanical motifs	Sensory variability
Water	Tree and columnar supports	Age, change, and the patina of
Air	Animals	time
Sunlight	Shells and spirals	Central focal point
Plants	Egg, oval, and tubular supports	Patterned wholes
Animals	Arches, vaults, and domes	Bounded spaces
Natural materials	Shapes resisting straight lines	Transitional spaces
Views and vistas	Simulation of natural features/	Linked series and chains
Fire	Biomorphy	Integration of parts to wholes
	Geomorphy	Complementary contrasts
	Biomimicry	Dynamic balance and tension
	Fractals	
	Hierarchically organized ratios and scales	

Light and space	Place-based relationships	Human-nature relationships
Natural light	Geographic connection to place	Prospect and refuge
Filtered and	Historic connection to place	Order and complexity
diffused light	Ecological connection to place	Curiosity and enticement
Light and shadow	Cultural connection to place	Change and metamorphosis
Reflected light	Indigenous materials	
Warm light	Landscape orientation/ landscape	
Light as shape and form	features that define building form	
Spaciousness		
Spatial variability		
Space as shape and form		
Spatial harmony		
Inside-outside space		

To further illustrate the elements and attributes it is helpful to look at a couple of examples that incorporate a variety of these attributes. The first example is Figure 4.

Figure 4. Jerusalem's David Citadel Hotel Kid's Play Room. Photo credit-http://www.thecoolhunter.com.au/article/detail/1955/jerusalems-david-citadel-hotel-new-kids-play room.

The play room stage area shown uses the repetition of the dominant colors blue and red, plus the yellow color of wood to add order to the visual complexity of the undulating lines in the cave-like form. This wooden structure adds *prospect and refuge* in the ability to separate those inside from the rest of the room, while also being able to observe what is going on in the room. The shapes that resist straight lines appear geomorphic as if the stage were mined from layers of the earth. The use of light and shadow inside the structure also adds to the curiosity and enticement of exploring the unknown interior of the structure and all that may occur while inside. This is a *central focal point* for the room with its dramatic size and dominant use of color and is also offering a *bounded space* through the enclosing walls. While the front plane is mostly open, it is

defined by the wrapping of the wooden layers as they undulate from the side around to the front

and create a further sense of enclosure.

Figure 5. Mattel Children's Hospital at UCLA Child Life Play Room. Photo credit
http://www.uclahealth.org/virtualtours/reagan/tourfiles/flash/index.html.

Figure 6. Mattel Children's Hospital at UCLA Child Life Play Room. Photo credit
http://www.uclahealth.org/virtualtours/reagan/tourfiles/flash/index.html.

Figures 5 and 6 show a facility that has many examples of biophilic inclusion within a

Child Life play space including direct access to the outdoors and natural ventilation with operable

doors and the large amount of daylight that comes in from the window wall. The flooring is also

polished to reflect the light as it enters the space, which creates pools of light around the

perimeter that draws your attention toward these spaces. The full spectrum of *color* is seen in the

mosaic tile and also provides *patterned wholes* through the individual distinct elements of each

piece of tile being joined into an overall pattern that abstractly replicates looking through the

water at a pebbled river bottom. This patterning provides further visual variety to the space and

serves as a focal point for the built-in wall area. There are also additional water themes found in

the room such as animal representations of sea shells, fish, and starfish in the door pulls and a

flooring pattern that adds biomorphic wave patterns that is categorized as a *Natural shapes and

forms* element. This sea theme connects the space to the ecology of the nearby ocean in a

representational manner.

Collectively, the biophilic design elements are significant in their ability to identify an

array of nature-based design features in the interior environment and the incorporation of the

elements is even more important in the modern world because of our increased separation from

the natural environment. The need for nature in the environment is its ability to elicit physical,

psychological, and cognitive benefits, especially important to children who are sequestered in the

hospital environment and in most need of every type of health benefit that can be provided. The

ability to provide nature-based benefits in a supportive space like a play room can maximize the

positive influence of the space. The play space is a space outside of the patient's room where the

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child can cope with their hospitalization by focusing on feeling like a normal kid through play, which is a primary goal for the profession of Child Life.

Child Life

The majority of a child's daily life should be spent at play and it is a mechanism that is used to test their abilities, through which they learn and socialize, and most importantly for hospitalized children, play can help children cope with the unfamiliar and express their concerns (Thompson, 1981). Play as therapy can include the use of activities such as reading, coloring, art projects, music, games and dancing (Paley, 2004). These are just a few of the types of enrichment Child Life uses in their play rooms and these types of play activities can benefit from biophilic environments that further support the children's overall recovery, wellbeing, and development.

Child Development

The importance of play is found in research that supports four child development theories that all support the importance of the environment and play for children's development. To highlight the importance of these theories a review of each follows.

Developmental Theories

Playtime has been established as an essential part of child development. Theoretical support for play influencing child development is found in Vygotsky's sociocultural theory and Piaget's constructivism theory; both theories say that child development is the result of the children's interactions with the environment (Ginsburg, 2007). Vygotsky's influence in his

sociocultural theory found that cultural factors influence child development (Feldman, 2009; Gottfried, 1986). He saw behavior as the result of a relationship between physical, cognitive, personality, social, and physical worlds. Additionally, he proposed that through exposing children to information that is intriguing, but not too difficult, the challenges increase their cognitive abilities. The information present in the environment is influential in challenging children and this idea was also adopted in the Montessori approach.

Piaget was a secondary foundation for Montessori. Piaget theorized that learning occurs in stages, showing an increase in quantity and quality of knowledge with development (Feldman, 2009). His theory was profoundly influential on the understanding of cognitive development and can be summarized by action = knowledge or learning comes from doing. He thought knowledge was a product of direct motor behavior. Taking these ideas, Montessori focuses on hands-on, participatory learning with a variety of designed materials that use play to foster sensory, motor, and language development (Feldman, 2009). An offshoot of Montessori is the Reggio-Emilia approach, which focuses on symbolic representation, as children are invited to explore their environment and themselves through expressive, communicative, and cognitive languages. This can be through many different activities such as words, movement, drawing, painting, building, shadow play, dramatic play, and music (Edwards, Gandini, & Forman, 1994). These activities are part of Piaget's structural-development theory, also known as constructivist theory, which shows that through the interaction of both the physical and social environments children develop new concepts and values (Feldman, 2009; Wadsworth, 1989). It is through these new constructs that knowledge is built and continues to increase the child's knowledge of the world and their physical abilities within it as they test their bodies against the world around them. These

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constructs can be built with the exploration of easily accessible and manipulative parts of the environment. Creativity and inventiveness, as well as the possibility for discovery, is directly related to the number and variety of the objects available in the environment (Louv, 2008). Play spaces can benefit from allowing multiple parts (toys and play objects for example) to be available to support various types of play and can aid in stimulating discovery and new construct formation. Most Child Life play spaces are open to children from infants up to and/or including teenagers, so they need to offer age appropriate choices of activities in order to support the physical and psychological needs of all children. The theoretical support for play is further defined in the various types of play, all of which need to be accommodated in a play room that serves multiple age groups. Play areas with multiple types of play can offer age appropriate challenges in order to support children in expressing themselves in many ways. This can include a combination of stage, reading area, media/gaming area, group activity area, and individual play spaces, to name a few.

Play

Play in all of its forms is a ubiquitous and significant phenomenon of development. The overarching premise of current child development theories is that play is essential for emotional well-being and cognitive, physical, and social development (Ginsburg, 2007). Four types of cognitive stages of play are defined by Piaget (Piaget, Gruber, & Voneche, 1995):

The first stage of play is functional play or playful repetition, which involves sensorimotor practice, is when the child repeats movements like dropping, banging, and throwing. Examples include working with blocks and exercising with graphic games. The second stage of

play is constructive play, which manipulates objects with a goal in mind. Children move from manipulating to formation and it results in creation. Art projects and puzzles are examples of this type of play. The next stage of play is dramatic play (pretend play) and uses symbolic transformations as one object is able to represent another object within an internal idea. It also includes games where situations are imagined and roles are taken on by others. The child can also play the role of many things at once. This is the made-up universe of storytelling that helps children exercise their mind. The last stage of play is games-with-rules and involves games with accepted rules and divisions of labor. Group play like this can be seen with children who work together in organized activities and sports (Gottfried, 1986).

Generally play changes in children with a gradual increase in group play as they mature. Functional play decreases while dramatic play and games-with-rules increase as children get older. Also, the frequencies of group games increases with age resulting in adolescent play mostly surrounding group play, thus teen play areas need to accommodate group play activities and areas.

All of these types of play have an important part in play spaces, as well as Child Life play rooms. The fact is that children use play to test themselves within their environment (Louv, 2008). This can activate potential based upon the content of their environment, so specifying space for children to play is important for overall health and development. With the majority of the modernized world spending 90% of their life indoors, developing an interior play environment using biophilic principles is necessary to support and foster both play and biophilia. The design of the hospital built environment can be a positive facilitator or negative impediment

for a child's contact with natural systems and processes (Kellert, 2008). This is especially true within play spaces.

Physical and Psychological Needs

Play influencing both physical and psychological needs can be found in various research resources. Psychological support for mixed age range play can be found in Montessori, where they have demonstrated that three-year age groupings of students serve to enforce where children are going and where they have been (Lillard, 2005). Children help one another, which serve as valuable experiences for the one giving the advice as well as the one receiving it. This can boost morale, desire to learn, and reinforce social connections. This is Vygotsky's sociocultural theory in action and shows the positive influence others can have on development.

Physical and psychological needs are challenged with our withdrawal into our interior environment, which has resulted in a lack of exposure to nature, a *Nature-deficit disorder* (Louv, 2008). This is not a medical condition, but rather the physical and psychological cost of our separation from nature. The symptoms include diminished use of the senses that extends to attention difficulties and can result in physical and emotional illnesses. The recent increase in childhood obesity, high blood pressure, and attention deficit disorder all point to some of the problems presenting themselves in children that are now being kept away from nature at greater rates than in the past.

A symptom of *Nature-deficit disorder* may be the 8 million children in America who are diagnosed with conditions such as attention deficit disorder and ADHD. Some studies suggest that biophilia may be useful as a therapy for Attention Deficit Hyperactivity Disorder (ADHD),

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perhaps replacing medications or behavioral therapies (Louv, 2008). ADHD is the most common neurobehavioral disorder in children and usually includes high levels of impulsivity, inattention, and hyperactivity that affect cognitive, behavioral, emotional, and social functioning. A few studies have already begun to establish a positive correlation between children's nature exposure, including playing in natural conditions, and the reduction of ADHD symptoms (Faber Taylor et al., 2001; Kuo & Taylor, 2004; Pellow et al., 2011). Research by Katcher and Wilkins has found success in their focused research with animals in therapeutic settings for residential treatment of ADHD (Katcher & Wilkins, 1993).

Attention-restoration theory was developed by the Kaplans and was inspired by the work of William James, who labeled two types of attention. Directed attention and fascination (involuntary attention) need to both be in balance (Louv, 2008). *Directed-attention fatigue* occurs after too much directed attention, like too much of a visually intense video game, and can lead to impulsive behavior, agitation, irritation, and an inability to concentrate. Wherever attention is automatic there's a strong amount of fascination and directed attention is allowed to rest. Creating spaces that promote fascination as well as promoting physical activity can relieve *directed-attention fatigue* and provide attention-restoration. This additionally supports biophilic design being used in play spaces, as natural features are strong in providing fascination due to the innate human need for their presence.

The importance of play and the various theories that surround it is well documented. It is complemented by the need for sufficient nature interaction in each stage of development, which is crucial in order to foster biophilia into adulthood. It also aids in providing the necessary fascination and directed-attention relief. Play spaces need to be designed to support child

development and also optimize biophilia interactions, all of which needs to be done within the challenges of the healthcare environment.

Children's Healthcare Environments

Healthcare Environments

Over the last fifty years the design of hospitals has disregarded the larger trends in architecture toward more sustainable building solutions (Guenther, 2008). As a particular typology, healthcare architecture has been able to isolate itself from advances in building technology and sustainability due to its complex regulations. Recent improvements in this trend offer us hope. Historically, following the invention of HVAC systems, healthcare environments became mostly separated from nature in a desire to isolate the interior from the exterior. Early efforts of sustainability focused mostly on energy savings and buildings became more air tight. Healthcare has been particularly prone to separation from nature because of the need to keep sterile control over the environment. Healthcare and children's healthcare environments have had a similar environmental history. However, we can avoid the overconsumption of energy and resources that these types of buildings have been designed to use. New thought processes for building design can produce buildings that reduce the normal massive amounts of waste while also not alienating people from the natural world. Kellert notes that:

> Both the knowledge and the technology exist to better reconcile and even harmonize the natural and human environments. However, meeting this enormous challenge will require two conditions. First we must minimize and mitigate the adverse environmental effects of modern constructions and development. Second, and just as important, we must design the built environment to provide sufficient and satisfying contact between people and nature (Kellert, 2005, p. 4).

The thought process behind the current drive to more sustainable buildings can be found in the idea of *restorative-environmental design*. This design theory strives to not only be more environmentally friendly, but give back and positively support the surrounding environment. It supports the biophilic idea that humans need nature and thus we need to take care of it. However, it needs to done with evidence-based design decisions, which have only recently begun to challenge past flawed decision making that has been slow to change (Cama, 2009).

The history of this type of environment has evolved over time. In medieval times, the hospital became a hellish fortress for the poor and insane where they were relegated to large multi-bed chambers with little ventilation or daylight. Florence Nightingale advocated in the 19th century many design changes for more sanitary conditions in hospitals including fresh air and light and became a beacon for change in hospital design and medicine (Verderber, 2010). Dr. Kirkbride of the Society of Friends in America believed in the use of a specialized mental health facility for removing patients from their surroundings/homes, which was thought to have been part of the cause for their mental state (Yanni, 2003). These hospitals were not to look homey at all. Dr. Kirkbride developed a stepped linear plan that became a major influence in asylum design or "institutional" design and included new design features like greater air circulation, fire-resistant construction, and access to large expanses of nature. To the Victorian designers, nature served an unquestionable good. After the civil war these facilities were overloaded and/or overbuilt to be too large to function as needed and thus not able to provide the proper healing environment. The result was a change to the cottage plan and the idea of making the environment more homelike, with patients working the nearby land of the homes opened to them in the community or in specially designed facilities. However, the benefits and challenges of the

"institutional" building still dominated treatment. From 1945-1974 there was a new focus on maximizing efficiency for making room for new technology, but mostly disregarding the need to design spaces according to their human occupants and their needs (Horsburgh, 1995). It was not until the Planetree model in 1980 that healthcare began again trying to put patients first in both healthcare and design (Montague & Montague, n.d.).

The history of Planetree started in 1980 at Griffin Hospital when their hospital needed to be redesigned due to declining admissions and projected losses. A survey of patients showed that they wanted certain amenities in the maternity wards like Jacuzzis and double beds. Their remodel went on to incorporate the survey suggestions, as well as other improvements, and subsequently became the fastest growing hospital in the state, receiving a Fortune Magazine ranking of the "100 Best Companies to Work For in America." This practice of looking to fill the patient's wishes has been repeated in other hospitals with similar findings. The Planetree founder, Angie Thieriot, talks about an ideal hospital as one that would combine technology and medicine for the best patient care outcome within a truly healing environment. Just being in the space could be healing ("Planetree focus is on giving patients what they want," 2003). A thought we can all support and one that nature can assist with attaining.

The Planetree model has been joined by others like it in the Pebble Project, which aims to provide research examples of improved patient and staff outcomes. The Pebble Project research has focused on growing the evidence available for design decisions and is using evidence-based design (EBD) to guide construction and publishing the outcomes to create a ripple effect of evidence available to all. Well-designed physical settings have a major impact in making hospitals safer, supporting healing for patients, and making a safer place for staff to work.

Focusing on patient care was also the founding reason behind the Child Life specialty, who seeks to help with the special needs of the pediatric patient in healthcare.

Child Life Profession

Child Life began with play programs for children in hospitals and can be traced back to 1917 with the official creation of the Child Life program. This has since developed into a well-supported profession with two objectives. The first objective of Child Life is to help children cope with the anxiety and stress produced from the hospital experience. Secondly, a child's growth and development should be promoted both in the health care setting and after their discharge (Thompson, 1981). The Child Life Specialist (CLS) provides therapeutic play that is developmentally appropriate and provides information for the child about the hospital environment. Sharing with the child the information about what sensations or physical feelings will result from a procedure is one example of how they help the child to understand what may be expected and how to better cope with the experience. The Child Life Council, the accrediting board for Child Life, notes:

> Because children process information from the world around them much differently than adults, they have distinct needs for managing the effects of stress and trauma. Without the assistance of a professional who understands their unique perspective, children of all ages may experience emotions such as fear, shame, confusion and loneliness, which can inhibit their natural development, and have lasting negative effects on their wellbeing (Child Life Council, 2010, p. 1).

The well-being of children can be enhanced through free play using any or all of the various types of play or through therapeutic play with a Child Life Specialist, an accredited trained professional. Therapeutic play typically consists of at least one of the following types of activities: 1) the encouragement of emotional expression, e.g. re-enactment of experiences

through doll play, 2) instructional play to educate children about medical experiences using constructive play with equipment and dolls aimed at practicing the process of the upcoming procedure to prepare the child, and 3) physiologically enhancing play (e.g. blowing bubbles to improve breathing) which uses sensorimotor practice (Koller, 2008). These types of play can be located in various environments, but is quite often accomplished either bedside or in the specified Child Life play spaces. The play space is best known by the Child Life Specialists because of their experiences in the space, how it supports play, and if the environmental features assist with their goals and needs for a play space used by their pediatric population. The ability to incorporate the support of nature during play in these environments may depend on the biophilic elements that are present. The Specialist is a unique source of information regarding the perceived benefits the environment, including biophilic features, has to offer play and their work in Child Life. The need for research exploring the current levels of biophilia incorporation lead to the resulting research questions regarding biophilia and Child Life.

Research summary

Since biophilia was first proposed by E.O. Wilson, investigators have documented positive effects of natural conditions on human beings. The experience of a built environment is similar to our experience in the outdoor environment as our bodies process innately this biophilic information. The built environment performs a crucial function to connect people with nature and together they both influence our health and well-being. The positive effect of biophilic design is seen when natural and artificial aspects of the environment merge. A few examples of this could include: "bringing nature into a building, using natural materials and surfaces, allowing natural light and incorporating plants into the structure" (Salingaros & Masden II, 2008, p. 63).

These features and more are part of the elements and attributes described by Kellert (2008). The positive influence play has on children's development is supported within Child Life play spaces that are seeking to provide play for preparation before medical events, normalization within the environment, and socialization for physical and psychological benefits.

Resulting research question

With the research supporting the incorporation of biophilia and play for well-being, the challenge of how to identify biophilia in play space environments led to the question of how to quantify biophilia. The specific use of Kellert's attributes and how they exist or whether they exist in the built environment, and whether they have any substantial influence in the space or on the occupants is not known. The first step to finding these answers resulted in the specific research questions for this project that were: Are the biophilic elements and attributes able to be found in the interior, specifically in the interior of Child Life play spaces? Also, what are the perceptions of Child Life Specialists regarding the interior design in these spaces and do they express biophilic preferences? These research questions were addressed through research of North Carolina Child Life play spaces as described in the following chapter.

CHAPTER III

METHODS & METHODOLOGY

This project involved a mixed method methodology that was planned to assess the primary question of biophilic content in interior Child Life play environments. A Biophilic Interior Design Matrix was developed and used to record the presence of biophilic elements. A second instrument was used to assess a secondary question regarding the perceptions of the Child Life Specialists and the play areas in which they work through an open-ended questionnaire. These data methods were then used to inform the development of case studies of each play space by using the questionnaire to qualify the matrix data.

Methodology

The choice of a mixed-method methodology using quantitative (the matrix) and qualitative (the questionnaire) methods was to provide a more detailed understanding of the research questions through the use of both methods (Creswell, 2011). While each method has limitations of its own, collectively they provided a better understanding of the research problem than either approach could offer alone. Mixed methods research also enables the use of a variety of tools regarding data collection and analysis that exceed the restrictions associated with using either quantitative or qualitative research methods alone.

Method

Mixed method design can be either fixed and/or emergent (Creswell, 2011). Fixed mixed methods design uses predetermined research processes and all the procedures are implemented as planned. Emergent mixed methods design uses mixed methods selected according to the issues that develop out of the research process. This study was planned to contain two phases from the start, but to have the details of the second phase emerge out of the fixed first phase.

The first fixed method phase of research used both quantitative (matrix) and qualitative (questionnaire) methods concurrently, as they were developed and implemented at the same time. These methods were not mixed. The second phase was an emergent design that involved using both of the previous methods for developing case studies. The combination of both types of mixed method design, fixed and emergent, is additionally supported by Greene, Caracelli, and Graham (1989) and defined as complementarity reasoning. "In a complementarity mixed-method study, qualitative and quantitative methods are used to measure overlapping but also different facets of a phenomenon, yielding an enriched, elaborated understanding of that phenomenon" (1989, p. 258). The first phase documented the play rooms in a quantitative matrix for defining what biophilic attributes were present. This information was used with the qualitative data from the surveys of the Child Life Specialists regarding their perceptions and preferences for their play spaces. The emergent method was the creation of 24 case studies of the Child Life play spaces, which was decided upon because it allowed for the unique data represented in each method to overlap and tell a more complete story about the play spaces.

Site Selection

The research process began by using the Child Life Council database for site selection with the following specific criteria:

- Country: United States

- Facility Type: Freestanding children's hospital or children's hospital within a hospital

These criteria resulted in a list of 219 U.S. Child Life locations. This list was sorted further by the total number of play rooms per state to see how many rooms each state included. This aided with the final selection of North Carolina Child Life play spaces for inclusion in this study, which was based upon the relatively high number of play spaces available within the geographic area of the state when compared to all other states, the ability to focus on a manageable number of cases, and the accessibility to the sites by the researcher. This produced a final list of 26 play spaces. Three of these spaces were determined to not be inpatient play spaces and eliminated from the study, while four additional spaces were found when contact was made with the hospitals and were added to the list resulting in 27 possible sites. Three of these were not able to be visited, so the final study included 24 sites (see Appendix B for a list of the sites).

IRB Approval

The research process began by submitting the appropriate documentation to the Institutional Review Board (IRB) at the University of North Carolina at Greensboro (UNCG) which determined that the project involved only non-human based research and therefore was exempt from further review. Each hospital IRB office was also contacted, with one site requiring

additional administrative approval. The approval included the request to photograph each play

space in order for analysis of the play room's features away from the facility, which decreased the

time required at the site and allowed easier access to the features in the room by those conducting

the reliability testing. It also aided the IRB approval process, as each reliability tester used

photographs of the site and thus did not require approval for their access to the site. The site

visits were planned with the Child Life supervisor at each facility for times when neither patients

nor staff were using the play areas so the photographic data could be collected. Twenty four out

of the twenty seven possible sites were visited. The three sites not visited were found inside two

locations that required extensive IRB requirements and were not able to be completed in the same

time frame as the others. Thus, the study was able to include 24 play rooms which comprised

89% of the play spaces available in the state of North Carolina.

Photography

The choice to use photography for documenting the play sites was because of its ability

for holistic exploration of the site by the use of unstructured (i.e. not pre-coded) photographic

data. Photographing the sites for this research was coordinated with the Child Life supervisor (or

their delegate) who met the researcher at an entrance and then served as an escort to the play

space(s). Each of the play space visits included a single trip to the site by the researcher, and

sometimes an assistant, to set up the digital camera equipment for the photographic

documentation of the environment(s). This study used a Panasonic DMC-LZ10 digital camera on

the intelligent auto setting with an automatic flash. Photographs of each area of the room were

taken including all walls, floors, ceilings, and furniture. The photos were taken during daylight

hours with overhead lights on. The spaces were photographed during the day and before sunset

for better lighting conditions and to prevent the need for flash photography as much as possible. Only one night feature was seen in the spaces that was a biophilic contributor. This was a site that had neon lighting that worked best at night, but it was visible in the daylight and was obvious in the photographs. The number of photographs taken was relative to the setting and depended upon the size, features, and design variety within the space and continued until all features were documented. The images were stored on a 2GB SD memory card and then also stored on a personal laptop, which was backed-up on a dedicated secure server. The resulting photographic evidence for the spaces was then processed into the design matrix.

Matrix Rating Instrument

The Biophilia Interior Design Matrix was designed by the researcher based on fifty-four of Kellert's (2008) design attributes that were applicable to interior design in play spaces. To clarify the design attribute terms used by Kellert, a Glossary was also developed to assist the researcher and those conducting the reliability testing to further understand the terms used in the matrix (see Appendix D). A list of Kellert's original seventy-two attributes is listed in Appendix E. Those that were not included in the data collection were for two main reasons. First the items included were only interior applicable attributes, as this study looked only at the interior environment but Kellert's list included exterior features. Secondly, attributes that were not able to be identified in photographs were not included, such as those that required understanding the human emotional interaction with the space. The resulting matrix was formatted into Kellert's six categories that he labeled as elements and attributes (see Table 1). As an instrument, the matrix captured the occurrence of biophilic elements in the space and consequently generated a numerical score for each space. Higher numbers indicated a greater variety of biophilic elements

(see Appendix F for an example of a completed matrix). The play rooms were assigned numbers to assist in identifying the sites in the matrix and the survey results and were assigned according to the order in which they were visited.

To test the usefulness of the matrix, a 1st year interior architecture undergraduate student used the matrix to evaluate the 1st year studio space in the Gatewood Building at UNCG. This revealed a lack of clarity among the wording that either the researcher used to describe Kellert's attributes or the actual wording from Kellert's definitions. The instrument was revised and tested again with 3 interior architecture graduate students, including the researcher, who each individually completed the matrix using the same photographs for the twenty-four play spaces. The photographs of the spaces were available to each of these 3 students via USB flash drive. The directions for completing the matrix included directions regarding when to mark an attribute as present in the space, which was according to the attribute's definition and whether the attribute was a reliable feature in the space, i.e. something that would be around at least seasonally. The features included were the structural, built-in features, and decorations, but also included larger toys, like train sets, that may not be permanent but a consistent feature in the room because of its size and scale. Smaller individual toys, which may be present one day but not the next, were included in the analysis only for their contribution to visual variety, texture, and color. These smaller artifacts were useful in that way, rather than as any other nature-related representation, because these toys were small and not only difficult to identify through photography but also did not greatly influence the overall perception of the environment. This does not mean that these items do not offer additional benefits to the individual user while interacting with them.

The responses of the 3 graduate interior architecture students were compared and any differences among the answers were resolved by a 2/3 agreement among the reliability testers. That is, two out of the three testers needed to agree on an answer before it was finalized. Each attribute's definition was also reviewed in order to see if there was need for clarification. Based on this review some of the glossary terms were revised to make it easier for future users of the matrix. This assessment of the matrix was compared with two additional graduate interior architecture students' matrix score results for every fifth play room visited, as a randomized validity testing for inter-rater reliability. The same instructions were used and the use of the researcher's laptop with the photographs, blank matrix form, and updated glossary. This choice of inter-rater reliability was based on it being "one of the best ways to estimate reliability when your measure is an observation" (Trochim, 2006). The results of this testing were an 89% agreement based on the average agreement of scores among the sites tested by the first rater and a 94% agreement by the second rater and thus proved a standard of reliability for the matrix instrument based upon standard social science statistical acceptance.

With the adjustments to the matrix and glossary supported by the reliability scores, the reliability of the matrix as an instrument reinforces its application by interior designers that are collecting data and analyzing the presence of biophilia. The collection of the data for this part of the study was supported by the established reliability of the matrix and supports the resulting scores as applicable for use in inventorying the biophilia found in the play spaces. The final matrix results are included in the analysis table (see Appendix G) and were further applicable for combination with the survey results in order to develop the case studies.

The process of surveying the Child Life Specialists occurred during the same time as the data collection for the matrices. Selection of these participants occurred because of their extensive knowledge of the play spaces. They are responsible for managing and using the play rooms and thus have the best knowledge of the space(s). Their responses were desired for indicating their perceptions of the environments and biophilic features in their play space(s). Creswell (2011) notes that identifying a group considered to be experts enables researchers to pose qualitative, meaning-oriented research questions and obtain unique pertinent data.

The questions were developed to elicit responses from the Child Life Specialists without biasing their knowledge of biophilic design elements or their presence and effect on play spaces. Open-ended questions provide the most opportunity for accessing true feelings, attitudes, and general preferences (see Appendix C for the survey). The process to send out the survey began with developing the questions with the researcher and thesis committee. It was also required in each of the IRB applications for study approval. One IRB office required a separate survey with an information sheet. During the study approval processes, the Child Life supervisors were asked to approve the use of the survey and if they would forward the survey to other Child Life Specialists who use the play spaces and could also complete the survey. The final draft of the survey was then sent to a Child Life Specialist and the thesis committee for final input. The approved final survey contained consent information at the beginning as well as the name of their facility and the name or room number of the Child Life play room. The survey questions were:

- How effective is the space in its support of Child Life? Please briefly explain your reply.

- What aspect of the space best supports Child Life? Please briefly explain your reply.

- Are there aspects of the space that impede Child Life? Please briefly explain your reply.

- If you could change anything about the space, what would it be and why?

The finalized survey was then sent by email to each supervisor with the following directions. A

modified email for multiple sites indicated the desire for a survey to be completed for each of

their play spaces. The unique web link to the survey was included in the email and an example of

the email is below.

> Please use the following link to access the survey that will help me better represent what Child Life Specialists feel regarding their play spaces. Please forward to all Child Life Specialists who use the play spaces. I greatly appreciate your time and assistance in completing this survey.
>
> Follow this link to the Survey: (a link was listed below)
>
> Or copy and paste the URL below into your internet browser: (a URL was listed below)
>
> Thank you and have a great day!

Follow up reminder emails were sent with similar language averaging every three or four days

until one survey for each playroom was obtained.

The survey questions were available through Qualtrics, an online survey provider. Qualtrics

stores the results anonymously and is password protected to shield the responses. The access to

the survey by the participants was via the email that included the web link directing them to the

survey and required no login, credentials, or password by the participant. No identifying

information was stored. The survey setting options included the use of the back button to enable

respondents to change their responses, save and continue to allow respondents to save and continue later, and was open access to allow those who had the email forwarded to them by their supervisors to be able to take the survey. The survey expiration date was initially set for one week. This time line was determined by a finding that generally seven out of eight responses arrive within the first week and that 90 percent of responses are usually collected in two weeks (Hamilton, 2009). But because the number of returned surveys was low, the expiration was extended until at least one survey for each room was obtained, which was just under four weeks.

Case Studies

The original intention of this study was to inventory the presence of biophilic design features and document the responses of Child Life Specialists for patterns that might reveal an association between their perceptions of the play spaces and the biophilic design elements present. Since most Specialists were involved with only one facility they could not comment on other facilities and this negated the opportunity to see patterns emerge from among the responses of many for a particular site. Instead, the surveys were used to qualify the presence of biophilic elements on a site by site or case by case basis.

A case study is an empirical exploration of a setting often using the collection of a variety of data and can use a variety of analysis tactics (Groat & Wang, 2002). Another benefit of case studies is that several case studies can be compared to reach more generalized observations (Yin, 2009). Case studies were determined to be appropriate for this research due to the fact that they offer many relevant characteristics including the ability to look at multiple cases in real life

contexts, their ability to expand causal links found in the research, and their use of multiple

sources of evidence, as seen in the use of the quantitative and qualitative data.

The survey data was used to qualify the numerical data found through the four open

ended questions. The questionnaire asked about the effectiveness of the space, the best aspect of

the space, the aspects that impede, and what they would change in regards to their space

regarding the work of Child Life. Reviewing these survey responses generally revealed that their

perceptions of the spaces were influenced by biophilic elements being present in or desired to be

added to their play spaces. The Specialists' responses revealed in question number one varying

levels of effectiveness and the responses ranged from spaces that were very effective, effective,

not effective, or general neutrality about the space. This was further verified through two other

interior architecture graduate students also reviewing the answers to question number one of the

survey and then indicating the effectiveness level perceived in the responses. Among the

researcher and the two reliability testers, a 2/3 majority decision on the effectiveness indicated

was obtained for the final labeling of the perceived effectiveness. In order to better understand

the association of the perceptions of the spaces and the biophilic elements in the space, the 4

categories of effectiveness found in the responses were color coded and listed with the numerical

assignment given to each space when completing the matrix (based upon the order of sites visited,

1-24). These sites were then arranged by number of occurrences of biophilic elements based

upon their matrix scores for easier incorporation into a graphical representation of the information

(see Figure 9. Survey: Child Life Play Room Effectiveness). This graphic revealed the strength

of the "effectiveness" response with the number of biophilic elements in the space. This

information along with the responses to the other 3 questions regarding the best supportive

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features, features that impede, and those features that they would like to change were used to

explain and describe the individual play spaces in a case study format.

CHAPTER IV

ANALYSIS AND DISCUSSION

Kellert's (2008) elements and attributes were used to provide a way to accomplish the primary purpose of this study, which was to document the biophilic design attributes present in Child Life play spaces in North Carolina healthcare settings and utilized a matrix developed for the study. A secondary purpose for this study was to determine what the perceptions of these spaces were by the Child Life Specialists, who best know the spaces, and was facilitated through a survey of the Specialists. The outcomes from both of these methods were used to create 24 case studies of the play spaces.

Matrix results

The primary purpose of assessing the variety of biophilic design attributes present in Child Life play spaces in North Carolina healthcare settings used scoring that was based on a credit/ no-credit rating as they offer no weight to the amount or quality of the item being identified. This weighting or qualifying of the features present may be further identified in future research, while the importance of identifying the variety of biophilia present was focused on for this research. The scoring of the variety of biophilic attributes within the matrix allowed for a maximum score of 52, one score for each item. All of the play room scores were then combined into a table for easier analysis, as seen in Appendix G. The total scores were averaged which produced a score of 21.5 and this score was divided by 52 (the number of attributes) in order to find the percent of biophilic presence, which was 41%. The score range was 25 showing a broad

range of diversity among the variety of biophilia present among the spaces. Each play space was also sub-divided according to the six biophilic element categories and then all of these scores were averaged. The final step was taking these sub-score averages and averaging them among each other in order to identify any bias among the number of attributes present among each element category, as they all varied. This resulted in a score of 3.67 as the average number of attributes present among all of the element categories. These scores were used to assess trends in the amount of variance among each play room from the averages identified for analysis in the case studies, see Figure 7 for the total scores of each play room.

N.C. Child Life Play Room Matrix Scores
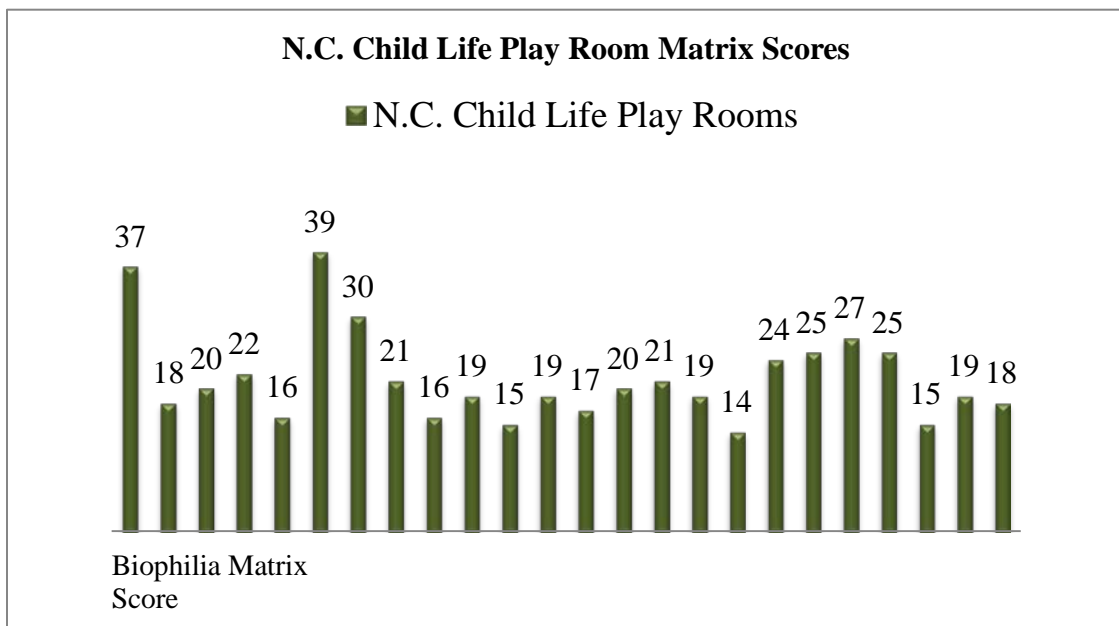
■ N.C. Child Life Play Rooms

Figure 7. N.C. Child Life Play Room Matrix Score Chart. In the order of sites visited.

What was found in the matrices was that the lowest scoring room was a small pediatric rehabilitation therapy/ play room that served both pediatric and teen patients and included an ocean theme. The space did have some biophilic variety; but it was small, windowless, not

recently renovated, served many functions, and would be a greater challenge to offer the same level of variety found in other spaces. The highest scoring room was a very large and spacious play room that offered the most indirect and representational biophilic incorporation, including a large two-story window wall with outdoor access, large salt-water aquarium, views out to a garden, a sandcastle play house, and a sea-shore theme.

The types of attributes found seem very appropriate for pediatric and teen play spaces. The uses of obvious representations of animals for example that may seem too theme like for adult spaces was welcomed in these play spaces and assisted with increasing the presence of the attributes and thus the variety of attributes scored. Variances within the different play rooms' scores included the highest above-average element, *Natural patterns and processes,* which was found consistently in every facility. Attributes like *bounded spaces* occurred in each play room, as they were all self-contained spaces, and *sensory variability /informational richness* were found in almost all of the spaces with multiple senses usually being documented. This usually included visual variety (color and variety in the choices of toys, for example), tactile variety (with the variance of tactile feature in the materials and toy choices), and auditory variety (usually with music and toys). The individual highest ranking attributes of all of the elements were color (present everywhere) and bounded spaces (all of the play rooms were distinct and separate entities). The next highest was *egg, oval, and tubular forms*, found commonly in the tubular steel in the chairs and tables, and the next highest was *natural materials*, which was present in all but two rooms and found in the use of natural wood (wood-looking laminate could not be included). These features are common in the interiors and yet we may not stop to think why they are so often chosen to be brought into the interior environment.

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Variances in below average levels occurred in the element categories of *Place-Based Relationships* and *Human-Nature Relationship (see Appendix G for the full analysis table).* This may be because it is easier to design a play room by including representations of animals and plants or other similar representational images than use attributes from these elements. It may not be as easy or may not as quickly come to the designer's minds the need for a connection to the culture or ecology in a geographical context or the benefit that merging certain biophilic attributes within a space has to offer. Individual attributes out of all the elements that ranked lowest include *change and metamorphosis,* which was not found in any of the spaces in the combined form of both change and metamorphosis (both needed to be present for this attribute). Also *warm light* and *fire*, which can be found together in a real fire, were not in any spaces. The lack of warm or colored lighting was a surprise to the researcher. Only one facility used colored neon and rope lighting that added visual interest to the space, but had cool colors. The use of cooler lighting to accent nature designs with blues and greens in them makes sense, but experimenting with areas of warmer colored lighting may enhance the biophilic presence and may create a zone of play that is more inviting. I think that this is an unexplored design element that may not have wide research attention for its specific integration into play spaces. *Fire* was not expected to be common, especially in a more southern climate like North Carolina and in a healthcare environment involving children, but is always a source of interest in a space and can be currently found in some healthcare facilities in public areas. It is worth looking at how this feature can be safely included in play spaces. *Hierarchically organized ratios and scales* were also not identified and were difficult to find in the spaces without more measured details of the space and its features and obvious examples that could have been easily identified were not found. The total absence of *plants* was also an interesting finding, but in healthcare there have been issues with live plants

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harboring fungus and bacteria, as well as requiring maintenance, which adds to the overall cost. Options like sterilized dirt and safely edible plants may be possibilities for future research. The increase of some of these features may be justified in the future with research supporting their specific inclusion or new ways sought to create safe and proper inclusion of them for children's spaces.

An interesting finding was that many design features supplied multiple attributes to the space. This allowed these features to increase the biophilic presence and became more significant to supporting biophilia variety in the room than their single attribute counterparts. This supports the product development for future children's room features and furniture to focus on experimenting with incorporating multiple attributes and further research documenting their influence.

It was expected and found to be true that the only type of *biophilia interaction style* present was *passive*, unless you count *active interaction* as including playing with the sunlight streaming in or playing in the fresh breeze entering the room, as *active interaction* requires an immersive experience with nature. The other biophilic presence that varied was the *organic or naturalistic dimension*, which defines shapes and forms in the built environment, and includes *direct*, *indirect*, and *symbolic*. Day lighting and fresh air were the only *direct* experiences that do not require human intervention for their presence, while the *indirect* included the one aquarium, the sinks, use of color, natural materials, and the views of nature. All the other attributes were *symbolic* nature representations. The opportunity for more of the *Environmental features* and use of *direct* and *indirect* experiences could be added to every play room and provides more existing research-support. The *representational* features are the easiest to add to an existing room and

Kellert's extensive documentation of attributes provides a vast amount of choices for incorporating them.

The use of the matrix was developed in order to assist designers with documenting the existing biophilic features in a space and for help with showing where opportunity for increasing the variety of attributes exists. The results of the play rooms' matrices were influential in the analysis of these spaces as individual case studies and were aided by the survey responses.

Survey results

The secondary purpose for this research was to determine the perceptions of the design of the Child Life play spaces and if they viewed biophilic features as preferred features in their spaces. This was facilitated through a survey of the Specialists, who are experts regarding these spaces. The experience that the Child Life professionals have regarding play was expressed in many of the surveys that indicated the importance of the play room and the benefit that play has for aiding coping abilities through developmental and therapeutic play, including socializing with others in these spaces. These play rooms are also most often a "safe zone" where no procedures are allowed and is a refuge from the stresses that the children encounter in the rest of the hospital, which aids in encouraging play and assisting with Child Life interventions. It also provides choices for the child at a time where freedom to choose is severely limited. This supported the assumption of this research that these rooms provide unique and important benefits.

The survey responses recorded biophilic preference for multiple biophilic features. The most common topic was a need for space (indicated in 54% of play rooms surveyed) and was either represented in a request for more space or a satisfaction with a large, open space

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(see Appendix C). More space was most often stated as allowing more patients to use the room and providing diverse activities effectively, thus increasing the room's positive impact. The two rooms that were marked as spacious on their matrices had survey responses that showed positive expressions about the space's support for the diverse activities available and both noted that the rooms were effective or very effective play spaces. This indicates that a sense of biophilic spaciousness may also support the spatial needs of Child Life.

Secondly around 30% of the play rooms had a specific request for wanting or appreciating nature-based design features. A preference for daylight and outdoor access, and a desire for these types of features if not present, was a recurring theme found in multiple survey responses. One survey indicated that adding windows and natural light would be a major uplifter for both patients and staff. Another item that showed up as being beneficial or requested to be added to the space was the use of music, which is one of the items that can add to the biophilic sensory variability in a space. Variety in the lighting was also referenced independently from daylight. One survey respondent wanted LED stars on the ceiling or a dimmable light so that patients could control their own environment. Another survey respondent indicated the desire for multiple types of lighting choices for a variety of uses. Three of the surveys also commented on the colors in the room and desired either earthy colors, more color, or brighter colors. One of these responses actually had already modified the room to include more color variety and representational nature inclusion with the addition of a nature-themed mural. Their facility has proposed more renovations for this room that will add nature representations through their material selections that will include earthy browns, snake skin looking upholstery, as well as a cork look for the craft chairs. These uses of color are a basic tool of the design trade that can be

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further researched as to how best they support children while increasing the biophilic variety of their spaces. There were additional requests for more cleanable surfaces in the survey responses and unique specific requests for furniture or building features. A review of the unprompted, recurring biophilic features indicated as preferable were spaciousness, daylight, color, light, sound, and materials.

There were also individual requests for specific activities to occur in the rooms that could add biophilic features and assist with future play room design. They included the following types of spaces: music system area, a defined infant/toddler area with soft floor area, craft/puzzle/board game area, computer area, art space with washable floor and sink, interactive white board, and medical play area. There were also specific teen spaces wanted. They include: teen interactive video game space, teen pool area, teen quiet areas for reading, teen physical activity space, and a lounging space for teen socialization. Storage was another recurring need that included floor level storage for a variety of activity options that could be accessible to children, as well as storage for supplies that are within quick access by the Specialists during the play room sessions. A large storage room near the play space also served this purpose. For safety concerns, cameras for EMU (Epilepsy Monitoring Unit) services were desired, as well as remote monitoring systems, cleanability of the features, and securing against theft. The play space has a wide range of needs and supports many activities and the survey responses added valuable insight into Child Life's view of these needs and preferences for their play rooms. Supplying these needs provides valuable opportunities for incorporating additional biophilic design features in the future and shows their current desire for numerous biophilic design features. The findings of the surveys

and the matrix results were incorporated into case studies of each space. Each of these case studies follows.

Case Studies

The following is the list of the spaces in the order they were visited and is the number used in the matrix analysis chart.

Figure 8. Play Room List

Play Room #-1- North Carolina Children's Play Atrium Room
Play Room #2- North Carolina Children's Jason Clark Teen Activity Center Game Room
Play Room #3- North Carolina Children's Jason Clark Teen Activity Center Teen Lounge
Play Room #4- North Carolina Children's Recreational Therapy Play Room
Play Room #5- University of North Carolina Charles Goren Music Therapy Room
Play Room #6- New Hanover Play Room
Play Room #7- Presbyterian Hemby Blume Playroom
Play Room #8- Presbyterian Hemby Teen Room
Play Room #9- Duke Children's Play Room
Play Room #10- Brenner Children's 6th floor Play Room
Play Room #11- Brenner Children's Teen Room
Play Room #12- Brenner Children's 8^{h} floor Play Room
Play Room *#13-* Brenner Children's 9th floor Play Room
Play Room #14- Vidant Medical Center Teen Lounge
Play Room #15- Vidant Medical Center Main Play Room

Play Room #16- Vidant NICU Play Room
Play Room #17- Vidant Pediatric Rehabilitation Play Room
Play Room #18- Levine 8th floor Play Room
Play Room #19- Levine 9th floor Play Room
Play Room #20- Levine 10th floor Play Room
Play Room #21- Levine 11th floor Play Room
Play Room #22- Levine 11th floor Teen Activity Room
Play Room #23- Jeff Gordon Teen Internet Cafe
Play Room #24- Jeff Gordon Play Room

The effectiveness of the play spaces as indicated in question number one of the survey responses was related to the scores of the matrix and used the play room numbering to organize the analysis. Figure 9 arranged this information graphically to show the perception of the play spaces as generally effective or very effective play rooms. The chart is organized from low to high scores.

Survey: Child Life Play Room Effectiveness

■ Not Effective Score ■ Neutral Score ■ Effective Score ■ Very Effective Score

Play Room #: ordered from low to high scores
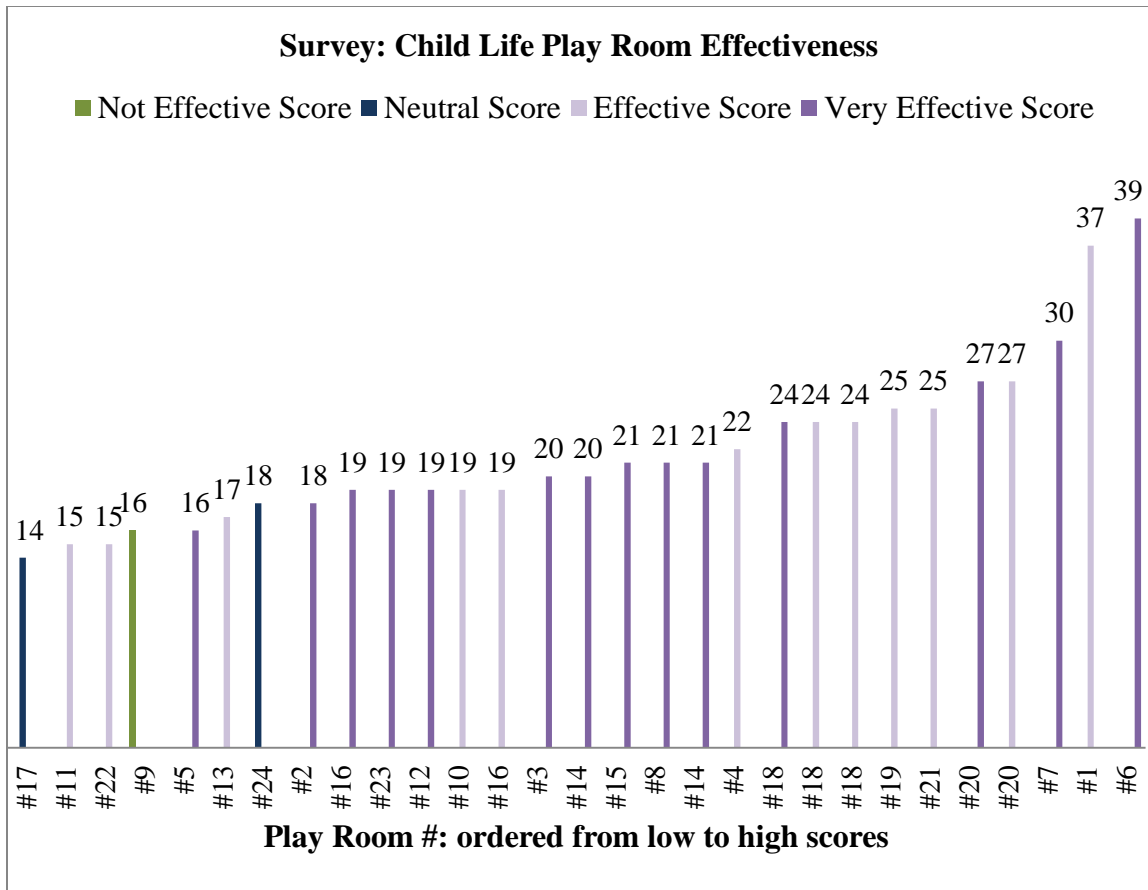
Figure 9. Survey: Child Life Play Room Effectiveness

The play room case studies follow and are numbered according to the order the sites were visited.

Play Room #1

The University of North Carolina Children's Hospital Play Atrium
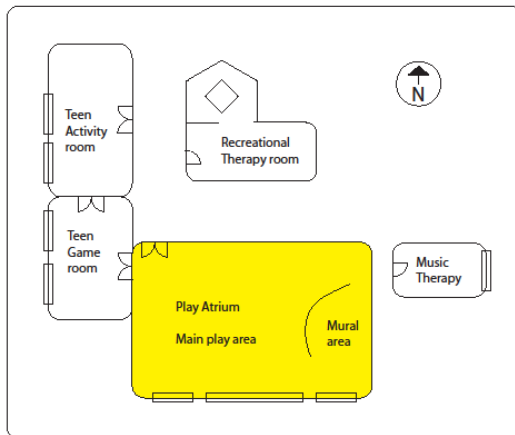
Figure 10. UNC Play Atrium Plan. Not to scale.

Figure 11. UNC Children's Hospital Play Atrium. Photo credit author.

Figure 12. UNC Children's Hospital Play Atrium. Photo credit author.

This play space has the second highest variety of biophilic attributes of the sampled play

rooms. Each of the six categories of biophilic elements had a majority of their attributes

represented in this space which was aided by the dominant use of a nature-based theme: a wooded

clearing near a river. The biophilic incorporation in this play area is seen in both architectural

and interior features. Architecturally it is seen in the structural components that determine day

lighting, views, and scale. The wooded clearing theme is reinforced by the large amount of

windows in the space that allow for maximized daylight, which includes the center raised ceiling

that adds to the sense of height while reinforcing the feeling of walking into a clearing from the

woods. This feeling is aided by the multilevel, biomorphic, tree canopy inspired, suspended

ceiling grids around the corners of the raised ceiling area. The architectural layout is a supporter

of the biophilic attributes that connect the play space geographically to the nearby woods, which

can be viewed through the window. The large scale of the room creates a spaciousness that

allows for the forest clearing theme to be effective.

This architectural incorporation of biophilia is further reinforced by the interior design features. The woodland theme is seen in the central tree-like tower play structure and the mural painting. It is also seen in the flooring color and patterning that mimics a grassland and river. Animals, insects, and botanical representations are included in the furniture and accessories. The spatial division of the interior creates a diversity of play zones that offer unique application of biophilic design attributes. The area by the mural offers the most biophilic variety with stuffed animal pillows, biomimetic water-like space dividers, and a geographically relevant mural painting, to name a few. The entire space offers diverse choices for activities through the division of space using varied ceiling heights and interior details like built in bookcases, computer interactive towers, the central play structure, the biomimetic divider, and the use of flooring material and color. This room's design features support a variety of types of play in each area, like interactive play, family centered play, and a specific toddler developmental play area.

The effectiveness of the room according to the survey is hindered by the design problem of needing more cleanable and accessible features, mainly the replacement of the rubber flooring for its inability to be sterilized and the large play structure that creates a barrier to patients with IV poles and is a safety concern for bigger toys with wheels. This area is planned for a remodel but the architectural features will remain along with their biophilic contributions, however many of the interior features may be replaced. This affords the opportunity to add new biophilic attributes that are also attentive to a greater diversity of patient requirements. Together the interior and architectural details have the opportunity to better support biophilia for the patient, but in the meantime biophilic features are found in almost every detail in the room and they offer a rich layered interior that help create what the survey identifies as a "safe, family-centered space".

Play Room #2

The University of North Carolina Children's Hospital Jason Clark Teen Activity Center Game
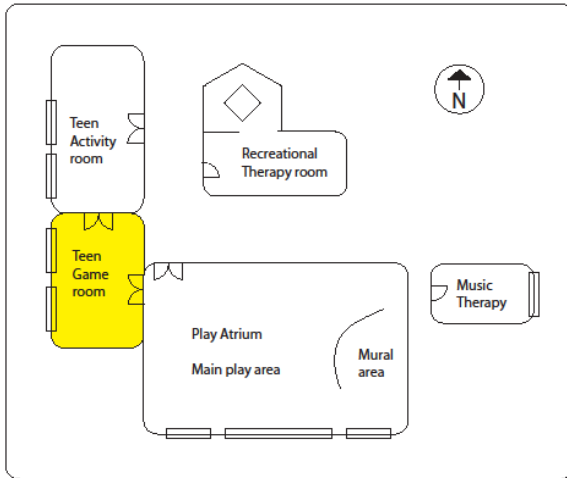
Room

Figure 13. UNC Teen Game Plan. Not to scale.

Figure 14. UNC Children's Hospital Jason Clark Teen Activity Center Game Room. Photo credit author.

Figure 15. UNC Children's Hospital Jason Clark Teen Activity Center Game Room. Photo credit-author.

This basketball themed teen room focuses on gross motor activity and group play activities. The survey response showed that the games selected allowed "more than 1 person to play thereby creating a social environment for peer interactions". It is also thematically linked to the University that the hospital is a part of, the University of North Carolina in Chapel Hill. This is seen in the blue and white color theme, as well as a painted animal mascot on the wall. The room's wood plank flooring looks like a basketball court with painted detailing to match. It goes along with the large basketball game in the room, pool table, air hockey table, and video game system.

Some of the biophilic features in this room include windows; although not operable, they do add daylight. They do not have a view of natural features and they have metal grating on them for security purposes. I actually think the security of the metal adds to a feeling of comfort in that it is safe and appropriate for teens to play with the types of games in the space. There is a large TV and game system area but little specific design attention is in this area of the space and there

is no seating; however that is available next door. The ceiling for the room features a recessed

circular soffit with blue accent lighting around the inner rim. The real wood flooring adds both

natural material to the space and the *integration of parts to whole*, where each piece of wood

when joined together creates something greater, a floor. The presence of sunlight, ambient

lighting, and accent lighting adds to the visual interest in the space and is seen in the above

average score received in the *Light and space* element. The lowest scoring biophilic element

category was *Place-based relationships* and would have been higher if the definitions for historic

and cultural connection to place were redefined. This was a finding among other spaces as well.

A broader sense of what could be defined as historic, ecological, and cultural is discussed in the

case study analysis that follows the case studies. The adjoining rooms add a sense of connection

to this space and are represented in the *linked series and chains* attribute. This linking allows the

current space to mentally expand to the adjoining rooms. They are however distinct from each

other and do not share any common design themes that could maximize on this connection.

The variety of biophilic presence in this room could be aided by adding *Environmental

features* and *Natural shapes and forms.* This could increase the room's score to at or above

average. As a teen room, it offers an array of activities that are not common in all teen play

rooms and it benefits from the adjoining teen lounge aimed at supplying additional activities.

The University of North Carolina Children's Hospital Jason Clark Teen Activity Center Teen
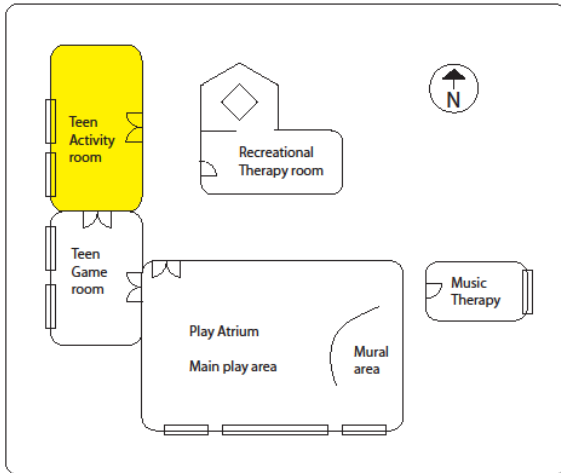
Lounge

Figure 16. UNC Teen Activity Floor. Not to scale.

Figure 17. UNC Children's Hospital Jason Clark Teen Activity Center Teen Lounge. Photo credit- author.

Figure 18. UNC Children's Hospital Jason Clark Teen Activity Center Teen Lounge. Photo credit- author.

This room features a variety of different options for activities compared to the sports-themed room next door. According to the survey it has "space just for teens; encourages social/peer interactions/ space to cook to create a feeling of normalcy." It includes a kitchenette and the only working stove seen in all of the play rooms. The stove has a safety mechanism, that the Specialists control, that allows for safe and unique activities with teenagers. Computer stations, board games, foosball, tables, and a TV/game lounge area make up the rest of this space. It is also scheduled to be remodeled but for now the spatial interest of this space comes from the ceiling detail that has a sinuous (seen in the biophilic attribute *shapes resisting straight lines*) dropped ceiling area that has accent lighting highlighting the edge (another biophilic attribute *light as shape and form).* It also has some multi-colored accent ceiling tiles and is painted in a cloud and sky pattern. There are additional trompe l'oeil wall paintings of rolling grass hills and wall paintings of windows with a view of the grass hills.

Other representations of nature that add to the biophilic variety in the space can be found in the historic connection to place seen in the painting of a previous patient on one of the walls and the ecological connection to place that is found in the use of the painted rolling meadow representations. These features aided in the slightly higher score for this room, compared to the sports-themed room next door. This room is tied as the second highest teen room score, however all of the teen rooms fell below average. Increasing any of the biophilic element categories could assist with increasing the variety of biophilic features, but a place to start would be adding a *central focal point* that could easily bring organization to the visual variety in the space. The TV/game lounge area and kitchenette are great additions to the activities available to teens in this facility and incorporate a variety of biophilic features. A potential remodel could allow for even more nature to support the goals of the space.

Play Room #4

The University of North Carolina Children's Hospital Recreational Therapy Room
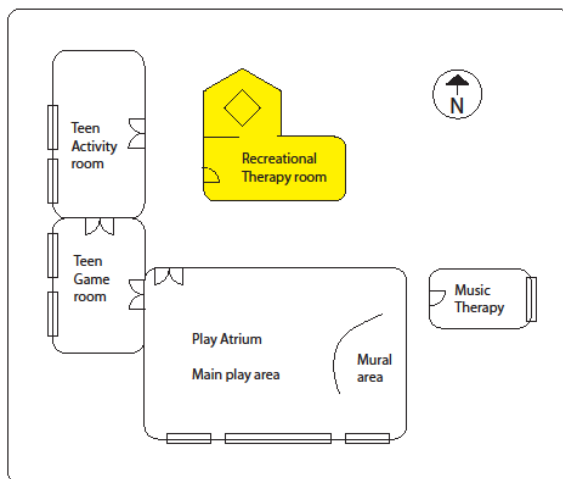
Figure 19. UNC Recreational Therapy Plan. Not to scale.

Figure 20. UNC Children's Hospital Recreational Therapy Play Room. Photo credit- author.

Figure 21. UNC Children's Hospital Recreational Therapy Play Room. Photo credit- author.

This play room is primarily used for younger children and features a separated infant/toddler play area with floor height mirrors, infant mat play space, and floor accessible toy storage. The space also serves as a play room for children on isolation, which prevents them from using the main play atrium. This area also features a skylight that adds unique definition and day light to the space. The skylight adds the biophilic attributes of *natural light, light as*

shape and form, and *spatial variety* through its addition of daylight and the extension of the ceiling plane that also forms a shaft of light.

The main play area has multiple dropped ceiling details that are accented with blue edged banding and blue suspended ceiling grids that contrast against the white ceiling tiles. This provides *complementary contrast* with its color use and *shapes resisting straight lines* with its curvilinear design. There is also accent lighting around each of the change in ceiling planes that adds the additional attribute of *light as shape and form.*

Together, both areas feature changes in texture, along with the other material variances that increase tactile variability in the room. The main space features multi-colored irregular floor tile patterning, while there is carpet in the infant/toddler area. The assortment of music and noise making toys and the TV's in the room adds audible variance. Together, the audible, tactile, and visual information represented create *sensory variability.*

The specific space planning and *spatial variability* in the design of the room allows for protecting small children from those playing in the larger space through the physical separation used to define most of this smaller play area from the larger space. It is also supported by the change in flooring materials, ceiling details, and the lower levels of lighting that allow the sunlight to softly and indirectly light the space. This further enhances the infant/toddler space as a calming play space, while the larger play area offers brighter lighting and more active types of activities. This *spatial variability,* as well as other biophilic features, creates well defined zones for different activities. However the "space has decreased (in half) in [the] past year or so due to renovations; not as much room for the children to be active" and included the removal of a large

aquarium. If the Child Life survey respondent could change the space they would "increase the size to allow for gross motor activity for toddlers and younger school age children." The benefits of more space for serving the population again seem primary for the work of Child Life.

Play Room #5

The University of North Carolina Charles Goren Music Therapy Room
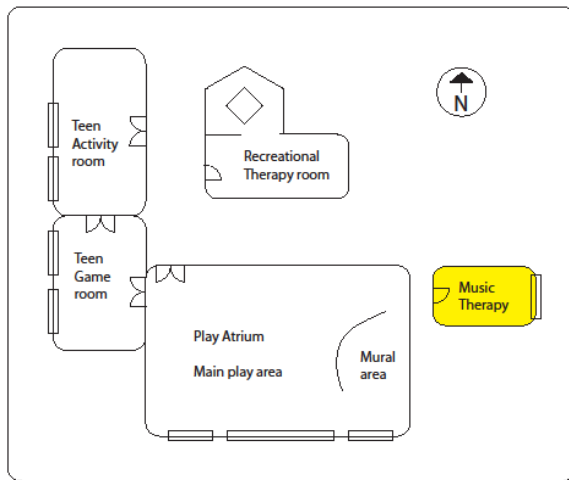
Figure 22. UNC Music Therapy Plan. Not to scale.

Figure 23. UNC Children's Hospital Charles Goren Music Therapy Room. Photo credit- author.

Figure 24. UNC Children's Hospital Charles Goren Music Therapy Room. Photo credit- author.

This room is a music therapy play room that offers many different activity choices that the survey response says provides an outlet for "expression of emotion". There are many musical instruments, a karaoke machine, and a recording studio that all use this very small space and the space is optimized by a large storage wall and built-in counter area. The large window wall adds a sense of extension to the space that assists with the small room feeling less restraining. The painted multi-color music motif on the wall adds to the whimsical feeling of the room and

features the biophilic attributes of *shapes that resist straight lines* and *color.* The use of color also adds to the visual variety in the room and accentuates the built-in desk's spatial definition.

The scores for this space included some high and low variances from the averages found among all of the play spaces. There were no features found in this space within the elements of *Place-based relationships* or *Human-nature relationships*. A greater connection to the local environment could include adding representations of the site the building sits on and /or of the regional geographical features. The human-nature element is present in a site if both of the named attributes are present, like *curiosity and enticement.* With the assortment of creative instruments available there is curiosity to be had with the options that abound in the room, but the space does not also offer enticement to explore the space, as it is so small and all of the features are identified upon first entering the space. This space tied for the highest scoring space in the *Natural patterns and processes* element, part of which is found in the wall of storage that features the piano keys which adds to the musical theme and creates a visual pattern. It also offers *complementary contrast* with the use of black and white and the *integration of parts to wholes* with the patterned repetition. There are sensory options available that create *sensory variability* with a variety of visual objects to look at, the tactile variety of each instrument and the interior finishes, as well as the acoustical options of music making. This room is also a well-defined space with a transitional area outside of the doors that can become part of the space when the doors are open and this landing then connects to the larger play room and offers a ramp for accessibility. Its linking to the larger play atrium adds the *linked series and chain* attribute while adding to a greater sense of space. This also aids in not feeling so confined by the smallness of the space.

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A larger space could accommodate more musical options and more patients at a time, but may lose the immediate access to all parts of the room that the current size offers. Either way, this space could offer more biophilic variety, but as is it supports the goals of Child Life in offering music therapy options within a space separated from (for noise control) but adjoining (for access) to the play atrium. Many facilities do not have a defined music therapy space. This room's design could support more group and 1:1 therapy if larger, but is a great addition to the other play spaces available.

Play Room #6

New Hanover Play Room
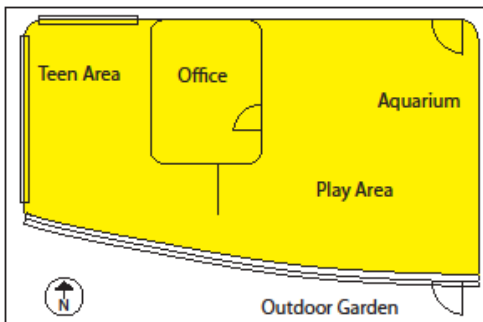
Figure 25. New Hanover Regional Play Room Plan. Not to scale.

Figure 26. New Hanover Regional Medical Center Play Room. Photo credit- author.

Figure 27. New Hanover Regional Medical Center Play Room- Teen Area. Photo credit- author.

Figure 28. New Hanover Regional Medical Center Play Room. Photo credit- author.

This play room had the highest biophilic matrix rating of all the play spaces and is

divided into three distinct spaces. It has a large open play area with an aquarium and large sand

castle, an office area with musical instruments, and a teen space. A major factor in the high

amount of biophilic variety found were the architectural and interior design features referencing

each other. The large two story window wall wraps around the main play space and teen area,

while extending into the nearby lounge area. This sense of connection is represented in the *linked*

series and chains attribute and creates a sense of place within the larger building. This sense of

place found in the spatial definition is aided by the design details in each area. The ocean side

design details throughout add to a sense of place in the larger ecology, relating to the nearby

ocean that is just miles away.

The architecture of the room adds to the biophilic attributes with its lowered one story

entry area that supports a sense of refuge and allows for prospect of the entire space. The

lowered ceiling also reinforces the sense of spaciousness that occurs when you enter the larger

two-story space. This entry area also houses the large salt water aquarium, which was the only

living animal incorporation in all of the play rooms. This was a more common finding outside of the play rooms and in entry or waiting areas, where the inpatients hardly spend time. In this room it adds both the *water* attribute and *animal* attribute. These two attributes are both found in the first element category of *Environmental features*, which this space scored higher than all the other play areas partially because of the aquarium. It also benefited from the windows and operable door to an outside garden. The operable door added access to fresh air, as seen in the *air* attribute and both the windows and doors added a view of the garden, the *view or vista* attribute. This play room scored highest or tied for highest in all of the other elements, as well. The diversity of the attributes present, as seen in the high scoring, corroborates with the positive comments by the Child Life Specialist, who uses the space. She says that it is a beautiful space and the "environment, lighting, and design are wonderful". Her desires for changes to the space are the inclusion of a sink and an emergency call button, as well as more resources and different furniture to make the teen area more appealing to the older children.

The use of innovative features that reinforce the theme and also add to the biophilic attributes present include a wooden boat play structure, surf board space divider, surfer imaged sun shades, the sand castle, the furniture, and toys which almost all represent the sea or a specific biophilic attribute. The floor layout and floor inlay design of the space also add to the sense of enticement by bringing you in from the sheltered entry area, into the larger play area, and then leading you around the central office and over to the teen space. Each area offers varied biophilic design attributes and unique things to see and do. The amount of open floor space and spacious layout seen here is the most common request by Specialists for their play rooms and allows for larger wheelchairs, patient with IV poles, and diverse activities to occur at once. This spacious

environment was stated as "having enough space for independent play and space for when working with Child Life staff" under the survey question that asked about the aspect of the space that best supports Child Life.

While most of these attributes are considered *representational*, a few of the things that this play room could add would be some *indirect* biophilic interaction that would allow patients to interact with some of the natural representations including *water*, *animals*, and *plants*. While there are obvious limitations to these within healthcare settings, innovative *indirect* interaction would be another area of biophilia that could open up new therapeutic benefits, as found in other research. The high satisfaction stated by the Specialist along with the high matrix rating for the space adds additional support for the benefit of biophilic variety within a play space.

Play Room #7

Presbyterian Hemby Blume Playroom

Figure 29. Presbyterian Hemby Play Room Plan. Not to scale.

Figure 30. Presbyterian Hemby Blume Playroom. Photo credit- author.

Figure 31. Presbyterian Hemby Blume Playroom. Photo credit- author.

Figure 32. Presbyterian Hemby Blume Playroom. Photo credit- author.

The children's play room at Presbyterian Hemby offers a space incorporating a meadow theme. The aspect of the space that best supports Child Life is having space available for "normative play and age appropriate developmental opportunities while children are hospitalized." The layout of the room supports many activities and each area feels unique but connected to the greater space because of the common design motif. The open floor plan benefits from a defined entry area which was not commonly found in other play spaces. The entry area is a great place of transition from the rest of the hospital into the play room, and offers the ability to survey the rest of the play room before entering in to play. This is included in the attribute *prospect and refuge;* a place to survey the area (prospect) and a sense of separation (refuge), which allows for patients to enter the space and then decide where they want to go. This can add a sense of control, which is a component that patients in a hospital situation greatly lack and is also something that play can support once they feel ready to enter and use the play room.

The overall matrix scoring for this space showed a high level of the *Natural patterns and processes* element that is found in the use of the representational nature-based theme, as well as

the restrained use of both open and closed storage. The use of storage in the room is unique in the way that the design uses small cubbies for toys that are built into the larger wall unit mimicking a rolling meadow. The wall unit adds to the presence of the attributes *color, shapes resisting straight lines, complementary contrasts,* and *integrations of parts to wholes.* This room also features a teleconference area that was unique to this space and useful for patients wanting to stay in contact with loved ones, which may further aid patients' coping abilities. This area had the least presence of the meadow theme, however. In the main play area the division of space led to additional biophilic attributes, such as arched gates (*arches, vaults and domes*), reflective paint on rounded partial walls defining the entertainment area (*reflected light, shapes resisting straight lines,* and *bounded spaces)*, a large tree representation between a play house and the sink area (*tree and columnar supports*), and metallic fleck glass that filters daylight from the next door teen play space (*reflected light* and *filtered and diffused light).* These features are part of how each space is divided into distinct play areas and adds to each space feeling unique and being able to offer diverse play opportunities. This array of play options adds to the success of the overall design of the room and is supported by the Specialist's thoughts that this room is extremely effective in helping provide normative play and age appropriate development opportunities.
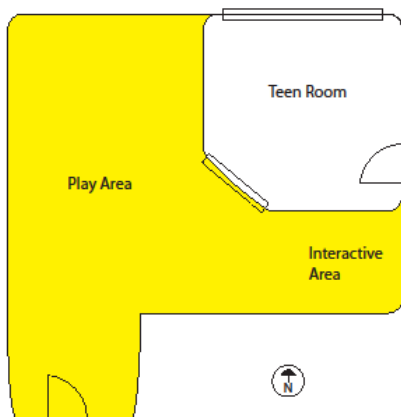
Play Room #8

Presbyterian Hemby Teen Room
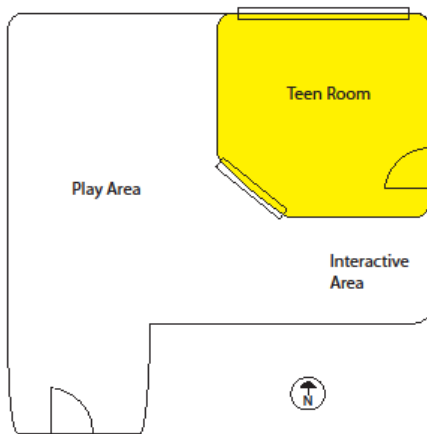
Figure 33. Presbyterian Hemby Teen Room Plan. Not to scale.

Figure 34. Presbyterian Hemby Teen Room. Photo credit- author.

Figure 35. Presbyterian Hemby Teen Room. Photo credit- author.

The teen room's design is dominated by the use of light and had a total scored that was the highest out of all the teen play rooms. It has one of the few rooms with operable windows and also has a large skylight. The room itself offers lounge furniture and a TV, multiple computers, crafting supplies, and a work table. The presence of the full height windows and skylight add daylight to these areas, but the artificial lighting levels in the room still allow for accent lighting to be used for light and visual interest. These accents lights also feature multiple biophilic attributes in their design and add a less childlike design scheme than is seen in the play room next door. The CD mobile in the skylight adds *color*, *movement*, a *central focal point*, and the *reflection* of light, which are all dominant biophilia additions to the room. The spatial variety seen in the change of ceiling height is one of the other *Light and space* attributes, which was the one element that scored higher than average. It is accompanied with *natural light* (windows), *filtered and diffused light* (through the use of blinds and the red metallic fleck glass), *light and shadow* (dramatic day lighting levels with lower artificial lighting in the outer areas of the room), and *inside-outside spaces* (connection to the outdoors with the small juliet balcony).

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This space had no *Place-based relationships* and had around the average scores for the other elements. The current pictures show a lot of boxes and supplies that were part of a donation made to the hospital for Child Life and represent the issue of storage that was also experienced in other facilities. The effectiveness of the space as indicated by the Child Life Specialist surveyed is through the variety of normalization opportunities available and is complemented by a space that doesn't feel like a hospital. The feeling of not being in a hospital comes from the design features in the space that include many diverse biophilic attributes like the large windows and skylight, which have a distinct influence on the overall space and its perception. This room scored lower than average because of a limited number of representational features. It could increase the amount of *Natural shapes and forms* without the need for a nature-based representational theme like the children's play space. The nature themes do make it easier to increase the variety of attributes present, but the same attributes can be found in teen-appropriate designs. The CD mobile is a great example of a singular feature adding multiple biophilic attributes into a space without looking childish or as if it came from an obvious nature-based theme.

Duke Children's Hospital Play Room
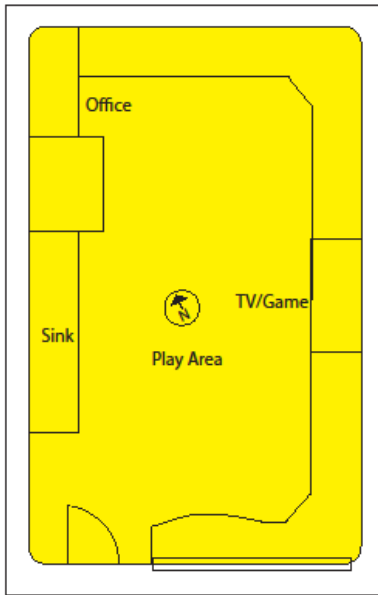
Figure 36. Duke Children's Play Room Plan. Not to scale.

(Photo not available)

Duke's play room supports children varying in ages from infants all the way through the teen years, and also serves as an office space. This play room is used as a safe zone, where no medical treatments are performed. The issues with this room surround the need for more space. The survey response indicated "the entire room is too small." Also, the response indicated that the amount of patients who could benefit from this room and the small size of the room create a major concern for the safety of those who use the room. The size becomes a major issue when multiple patients are in there at the same size with wheelchairs and/or IV poles. The potentially

dangerous traffic jams could be alleviated with more space. There are different areas of activities defined in this space to support the various ages of the patients and include a multipurpose round table, Wii play area, infant mat and toddler play table area, storage around the perimeter, and space for music therapy. The round table is able to accommodate several children at a time and is the feature that the survey listed as the most supportive feature in the room. There is also floor level storage for child accessibility; however the small size of the room is a challenge for Child Life to provide all the age levels appropriate toys and supplies.

There is a mix of biophilic representations in the room that are not cohesive, but do add biophilic attributes and some aesthetic interest in the space. The giraffe print ceiling border does not match thematically with the starfish floor inlay. There is also a red undulating laminate counter along the window wall that could easily be tied into some other feature in the room, but doesn't currently. Each feature adds to the presence of the biophilic attributes but does not result in a cohesive design. It also does not reference the local environment, which could assist with feelings of place and familiarity for children feeling disconnected from familiar territory.

Day lighting is present from the other side of the hallway and in through the glass windows. These windows have blinds to moderate the light and the view from people in the hallway seeing into the play room. The blinds are open when the play room is having a play session, as an indicator to others that the room is open. The height of the windows does not allow for smaller children to be able to view much more than the heads of the people walking by. The dutch door also has the top opened when the play room is in session and allows taller children to see out of the door and out through the exterior window across the hallway. As one of the lowest scoring rooms, the main complaint is a need for space. More space would allow for more division within

the space and for more children to use the space at the same time, ultimately benefiting more patients. The lack of responses concerning specific nature-based features in the survey seems secondary to the immediate needs of accommodating all the patients in a safe manner.

Play Room #10

Brenner Children's Hospital 6th floor Play Room

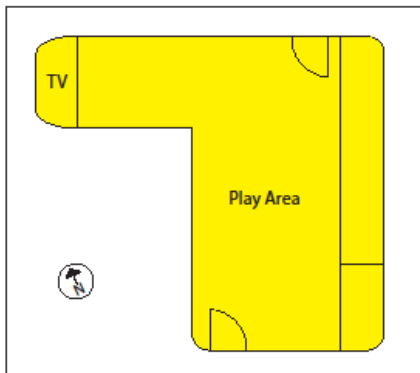*Figure 37. Brenner's 6th floor Play Room Plan. Not to scale.*

Figure 38. Brenner Children's Hospital 6th floor Play Room. Photo credit- author.

Figure 39. Brenner Children's Hospital 6th floor Play Room. Photo credit- author.

This floor plan is in an L-shape that has a recess with a TV and toys. The main open

floor space is surrounded with cabinetry and shelving and has a work table centrally located with

a train set next to it. The dark cabinetry is complemented by the bright yellow walls and adds to the bright and cheerful atmosphere, as stated by the Specialist in their review of the space. The only changes the surveyed Child Life Specialist requested was to make the room larger and to get new carpet. The aspect that best supports Child Life on the survey list was that "the playroom provides opportunities for play and expressive activities to encourage normal development and a sense of fun in spite of challenging circumstances. The playroom has play centers and a wide range of art supplies. The room helps normalize the hospital experience."

This space does not include any *Place-based relationships,* but a high level of *Human-nature relationships.* The results of this could be a lack of a sense of place that makes this room not connected to the hospital's location. It could be anywhere. There is, however, a sense of connection to nature and people, as seen in *prospect and refuge, order and complexity,* and *curiosity and enticement* that were found. The spatial layout of the room provides support for each of these attributes and is another example of how a single feature can influence several attributes. The layout allows for a place of both prospect and refuge in the TV recess where there is a sense of separation, or refuge, from the main play space and the opportunity for prospect by viewing what is going on in the rest of the space. A child in this area can be playing with the various toys while still outside of the main space. The L-shape also adds to the complexity in the spatial definition, and is paired with the various organizational furniture units for storage of supplies that aid the sense of order. The large number of activities that are visually on display for the children to see adds to a sense of curiosity and the undiscovered path within the L-shape layout upon entry into the space brings out a need to be drawn deeper into the space in order to explore it.

<u>*Play Room #11*</u>

Brenner Children's Hospital Teen Room
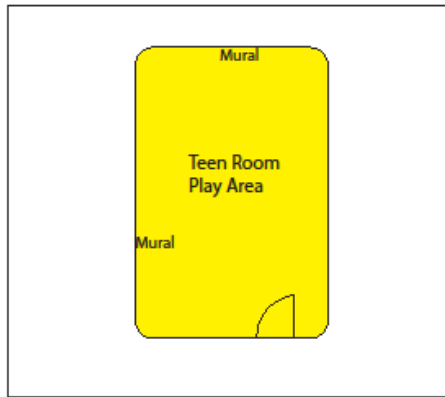
Figure 40. Brenner's Teen Room Plan. Not to scale.

Figure 41. Brenner Children's Hospital Teen Room. Photo credit- author.

Figure 42. Brenner Children's Hospital Teen Room. Photo credit-author.

The teen room for Brenner's offers teen appropriate activities such as a TV/game lounge area, a pool table, piano, computer area, and additional activity tables. The space is divided into these different zones and yet is unified by the dramatic woodland mural that adds visual interest and multiple *Natural shapes and forms*. The mural adds to the nature interaction where the space may otherwise have had a limited access to this large of a scale of representation because of the lack of windows with a view.

It also has a lower than average score for the last three elements, which could provide a possibility for increasing the biophilic variety. These elements were hindered by the lack of daylight and access to the outdoors, as well as the uniformity of the room's architectural features. The suggestion by the Child Life Specialist for more space when redesigning the space the last time resulted in 20 additional square feet, but it is still tight when IV poles and other equipment such as wheelchairs are trying to use the activities and move through the same space. There is

also a lack of space for bed-bound patients. Kids that are bed-bound then lose out on the "opportunity of change of environment from [their patient] room and social opportunities." This space was created to allow teens to control what they are able to do, as control is an issue for teens that have lost most of it when hospitalized.

The survey results indicated that the past few renovations included changing the wall colors and adding the mural, as well as changing out two huge, tall square tables for two smaller tables. This was because one person would want to do crafts while another play a board game or a puzzle and so smaller tables worked better. The mural is noted as being a favorite among the visitors to the space and "really makes the room feel open and gives the sense of nature". The survey response also indicated that if a change could be made to the space, they would make it larger and add a window for natural light. Also, additions for surround sound with relaxing music and altering the lighting would be preferred. Adding features like LED stars on the ceiling or dimmable lighting for patients to control in addition to the other suggestions would help promote effective patient coping. Their facilities planning recently asked Child Life for their input on some re-upholstery choices and the Specialist thinks the changes will bring the theme of the room together with a snakeskin patterned earthy brown fabric and a tree-bark look for the craft chairs.

Brenner Children's Hospital 8^h floor Play Room

Figure 43. Brenner's 8th floor Play Room Plan. Not to scale.

Figure 44. Brenner Children's Hospital 8th floor Play Room. Photo credit- author.

Figure 45. Brenner Children's Hospital 8th floor Play Room. Photo credit- author.

This play room is actually two play spaces in one because of a moveable dividing wall,

but it serves as one space most of the time. The greater length of the space compared to its width

is balanced by the wall of windows along half of the room. These windows add transparency to

the space and add visually to the appearance of the width of the room. They also add a botanical

motif with tree leaves etched in the glass. The variety of toys available in the storage below the

windows adds to the visual information that is found in the space and adds a wealth of play

opportunities. The large round column and the two groupings of built-in storage units offer

additional spatial definition. The variety of open and closed storage in the room is another

addition to *complementary contrast*. Near the column is an angled built-in shelving unit that

references the entrance doors, which feature angled glass within a solid wood frame. These

angular features offer *dynamic balance and tension* with the positioning of the angles feeling

unstable or dynamic, while the overall unit looks visually balanced and solid due to its weight and

solid material construction. An interesting biomorphic feature is the ceiling lights that have a red protruding cylinder from a yellow disc, loosely referencing a flower or lily pad. This attribute is found in the *Natural patterns and processes*, which overall scored below average. This play room did score higher than average in the *Natural shapes and forms* element. This can be found in the wide use of representational images of nature in posters, stickers, large toys, and artwork that was found near the built-ins and added onto the large planes of wall and laminate in these areas. There was no *Light and space* or *Place-based relationships* present. The lack of day lighting and variety with the spatial definition were contributors to a lack of these elements. There is a wide central aisle that divides the space into two long halves that creates space with work tables on each side and adds order to the room. The Specialist for this space considers the space very effective and large enough to accommodate age ranges from birth up to and including some teens. The large amount of space also allows for socialization, which along with the room being a safe room away from medical procedures, aids in normalization. One of the built-in areas is specifically designated as an infant/toddler area and play space, with appropriate toys and games, etc. nearby. A complaint for this room is that it is outside of the patient unit and is locked due to its location. A volunteer or staff is required to open the space to patients. The lack of indirect nature interaction, such as daylight, or the need for more biophilic attributes is not mentioned, but the safe environment that serves the function of play intervention and socialization seems to be the primary reason for the high satisfaction level.
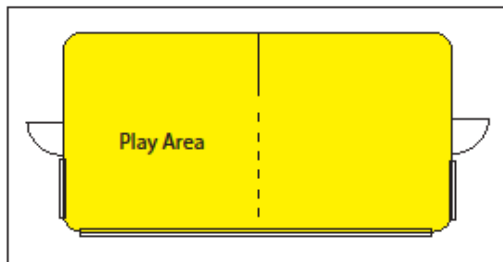
Brenner Children's Hospital 9th floor Play Room
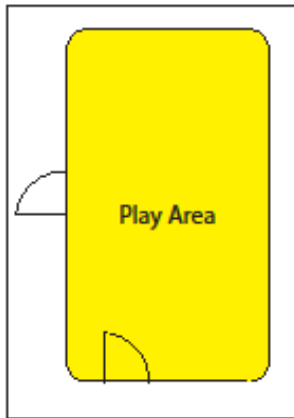
Figure 46. Brenner's 9th floor Play Room Plan. Not to scale.

Figure 47. Brenner Children's Hospital 9th floor Play Room. Photo credit- author.

Figure 48. Brenner Children's Hospital 9th floor Play Room. Photo credit- author.

This play room mostly serves the hematology and oncology patients. It was recently renovated with design input from one of the Child Life Specialists and benefits from a bright color scheme and bamboo patterned built-in shelving that adds order, visual complexity, and *biomorphy* (lime green bamboo patterning). The small size of the room (a definite lack of spaciousness) compared to many of the other play rooms hinders the number of patients that can use the space, as well as hindering the work of Child Life in providing appropriate spatial allocation to the different age requirements of the patients that may be in the room at the same time. The space is maximized by the use of the storage and matching design features throughout the space that also adds to the spatial harmony. Because this room has no windows or access to daylight the *Light and space* element is represented below average and increases the closet-like feeling of such a small space. The rest of the elements scored close to or just below the average level of inclusion, except for *Place-based relationships,* which was not represented at all. As a

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result, this space has the feeling that it could be anywhere. A greater sense of place could be achieved through linking to the local geography, history, ecology or culture and could add the possibility of telling a local or regional story. This could also add a greater biophilic connection that is more affordable than trying to add some of the *Light and space* attributes in the room, which could involve extensive and costly renovations to add either a connection to the outside or greater variety in the spatial definition.

<u>*Play Room #14*</u>

Vidant Medical Center Teen Lounge

Figure 49. Vidant Teen Room Plan. Not to scale.

Figure 50. Vidant Medical Center Teen Lounge. Photo credit-author.

Figure 51. Vidant Medical Center Teen Lounge. Photo credit-author.

The teen room at Vidant, while small, offers a pleasant atmosphere with diverse

attributes. This is represented in the survey response indicating that "there are a good amount

[of] seats and activities to do. A bed could fit along with a couple other people." The features that add to the above average level of both the *Natural patterns and processes* and *Light and space* elements are major contributors to the overall effect of the space. They include sensory variability features found in the noise produced from the Bose sound system, various game equipment, computer, TV, etc. This also includes visual variety in the patterning, change of materials, furniture and games available, as well as the decorative features. Tactile difference is found in the upholstery, hard flooring, laminates, decorative features, metal mirror art, window and shades. The mirror art serves the purpose of visual and tactile variety, while also adding to *integration of parts to wholes* with its component makeup. The mirror components are also *fractals* with the scaling of the same circular feature. It also reflects light and along with the window are some of the features present in the *Light and space* element.

The other four elements scored either a little above or below average, and the easiest to address would be the low level of the element *Place-based relationships*. This could be added to the room through additions that created a sense of history, ecological place, or culture using native materials. The survey responses indicated that the limited size of the space minimizes the full potential the room can provide. The Specialists would like to enlarge it and make space for interactive teen games and specific areas supporting activities such as reading, physical activity, and a lounge area for socialization. There was also a request for more natural light and a door that could access a balcony for patient to feel fresh air and the warmth of the sun. The ability to add such features would increase the biophilic variety further and support the desires of the Specialists for offering greater therapeutic access to nature in the environment.

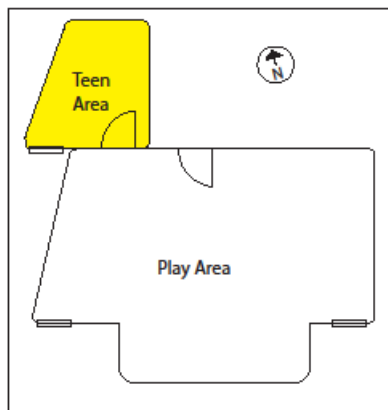Vidant Medical Center Main Play Room
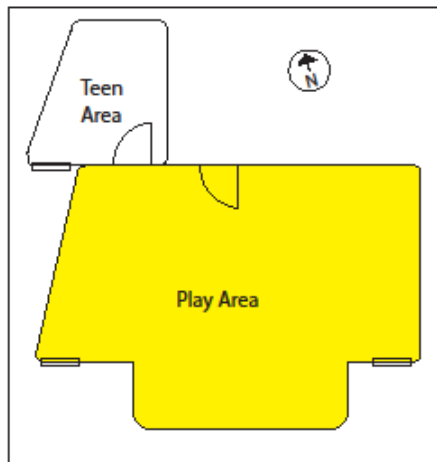
Figure 52. Vidant Play Area Plan. Not to scale.

Figure 53. Vidant Medical Center Play Room. Photo credit-author.

Figure 54. Vidant Medical Center Play Room. Photo credit-author.

The main play room for Vidant Medical Center is a space that benefits from an earth-tone color palette of blues and browns and has a seaside theme that is relevant as a *Place-based relationship.* This facility is within a half an hour drive to the ocean, and while not found immediately outside, the ecological connection of the ocean to the region is a relevant theme and contextually appropriate for this facility as incorporating biophilia. A historic connection to place is included through a plaque in honor of a donation made to the play room in the name of a previous patient and adds another *Place-base relationship,* providing a connection to the past.

The space includes two full-height windows with roller shades that add pools of light toward each side of the play room that draw you through the space as you enter in the middle. This space is informally divided into separate areas that offer diverse activities. The orderly use of limited furnishings and built-in storage allows for maximized floor space for patients confined to their beds or wheelchairs to be wheeled throughout easily. They have ample space to

maneuver in this room, something other play spaces requested. Having a variety of activities

visually available for selection in open built-in storage units offers orderly enticements while

adding visual complexity. This complexity, when paired together with order, organizes these

items into the *Human-nature relationships* attribute of *order and complexity*. It also adds to the

room's visual harmony. *Order and complexity* are one of the primary biophilic impacts that you

see when you visit this space. Additionally the use of order, open space, and the dominant blue

color combine to appear calming. The use of wood plank-looking flooring adds multiple

attributes: color, visual texture (a component of sensory variability), as well as the *patterned*

wholes attribute (because of the individual pieces that appear to be united into a singular whole,

the floor). This is another example of how a single feature can impact a space while offering

multiple biophilic attributes. It serves as a major design feature that contrasts with the rest of the

colors in the room. It creates a color plane opposite the walls and thus a *complementary contrast*

and further increases the biophilic variety.

The room is missing a connection to the outdoors and a survey comment for this room

indicated a need for more natural light and access to a balcony where the patients could get fresh

air and play in the sun and do activities such as working with chalk. The flexibility of the

furniture was also noted in the survey as a feature that they appreciate with the adjustable height

on the tables aiding wheelchair access. Features like the adjustable tables could have modified

table tops from the rectangular shape that they are to maybe wrap the body and resist straight

lines (a biophilic attribute) while incorporating a *patterned whole* when multiple table tops are

used together. The biophilic environmental needs and anthropometric needs of the users of the

space thus could be combined into features that function in the hospital setting and also increase

the nature connection. This could create a multiple attribute biophilic furnishing and meet the

patient's needs. This space is a good example of how the spatial definition, use of storage, and

restrained use of furnishings may assist patient access to and through a space while also offering

multiple biophilic choices in a "very effective" play space that is an "open, friendly, and fun/cool

atmosphere."

Play Room #16

Vidant NICU Play Room
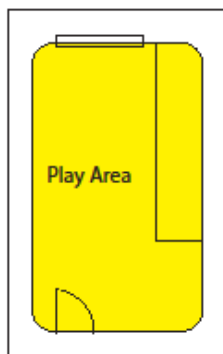
Figure 55. Vidant NICU Play Room Plan. Not to scale.

Figure 56. Vidant Medical Center NICU Sibling Play Room. Photo credit-author.

Figure 57. Vidant Medical Center NICU Sibling Play Room. Photo credit-author.

The NICU play room is the only one being included that the inpatients do not use for

their play. They may come into the space, but the play equipment is used to prepare the siblings

to see their new brother or sister in the NICU, as they are either premature or needing medical interventions. This space provides support for the siblings to be prepared to interact with the patient in a manner beneficial to both of them and to understand what is happening with their new baby sibling. As a play room, the space supports: a small variety of items for play, interaction with others, and aids in the engagement in therapeutic activities. The room is small, but used one on one or for small group activities, such as a family, and features a full length window that looks out onto a garden area. This window visually extends the space and aids in the space not feeling claustrophobic. The biophilic and visual variety present is mostly found in the things that the sibling or family interacts with like the bead wall toy, the cut-out fish detail on the chair backs, the aged wooden furniture, and the tree fort drawing. The child height sink allows the siblings to interact with water while also sanitizing their hands. The one side of the room is visually dominated by the cabinetry and provides very little visual variety or interest, but a practical necessity.

The Specialist surveyed would like more storage space and also more room for larger groups to use the room at the same time. Another survey requested more adult sized chairs and group activities that could be made available in a larger space. The current space supports the work of Child Life interventions with the siblings, through access to materials and the small size allowing close proximity for all of the children in the room to the adults. However, the addition of more space could function to accommodate more patients and increase overall effectiveness. The use of nature and its elements seems secondarily important in the minds of the Specialists compared to the practical need for space and storage in order to provide support for more patients. The below average scores show that the biophilic variety could be increased and could

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specifically include greater connection to place through the *Place-based relationships*, offering

another layer of familiarity to the families who use the space.

Play Room #17

Vidant Pediatric Rehabilitation Play Room
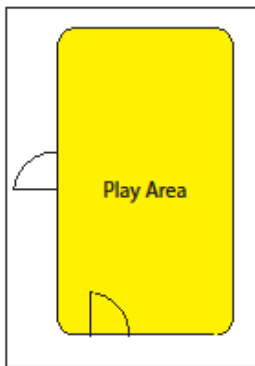
Figure 58. Vidant Rehabilitation Play Room Plan. Not to scale.

Figure 59. Vidant Medical Center Pediatric Rehabilitation Play Room. Photo credit-author.

Figure 60. Vidant Medical Center Pediatric Rehabilitation Play Room. Photo credit-author.

This room is in another part of the facility from the other rooms and supports the

rehabilitation program. The inpatient children use this space for one to one group therapy and as

a supervised-only teen lounge. The desires of the Child Life Specialist is for a room specifically

designated for free play for all ages, but the unit this play room serves is too small so they

combine therapy and supervised play uses within this space. This is also a safe room where no

medical procedures are performed, but it is used for a variety of types of play: medical teaching,

emotional expression activities, developmental play, social interaction sessions, modifications for

play, and sibling play/education sessions. If there were modifications to this room the Specialist

would like a bigger space and/or two rooms with a designated younger room with a soft play area

and a teen room with a pool table, music system, and an interactive video system. Preferences for

both rooms include a washable floor, sink, and interactive white board among other things. All of

the requests represent the tools of the trade the Specialist would like to be able to offer that are now restricted in the current space.

This was the lowest scoring space of the play rooms surveyed. The total absence of the element *Light and space* can start to be explained by the lack of sunlight and differentiated spatial layout. As well, its limited representations of nature in the room led to average or below average ratings in all of the element categories. This space could benefit from greater differentiation of the space, which could be facilitated easier with a larger space and could then accommodate even more patients and activities at a time. The lack of any *Human-nature relationships* and only one *Place-based relationship* along with the lack of *Light and space* allows for plenty of options to increase the variety levels of biophilia in the space within any major construction to the room.

Play Room #18

Levine 8th floor Play Room

Figure 61. Levine 8th floor Play Room Plan. Not to scale.

Figure 62. Levine Children's Hospital 8th floor Play Room. Photo credit- author.

Figure 63. Levine Children's Hospital 8th floor Play Room. Photo credit- author.

The 8th floor play room has the typical spatial definition of all four of Levine's pediatric

play rooms, but serves the youngest patient population. The effectiveness of the space was

responded to in the survey as giving the Child Life Staff "ample amount of space to initiate group medical play sessions, therapeutic play experiences, as well as other interventions needing to take place in a playroom setting. We have storage space to keep specialized materials for these interventions as well as a locked area designated for cleaning supplies." This room includes a curved dropped soffit that swirls through the space and leads to a large window wall. The soffit adds to the biophilic attributes of *spatial variability*, *light as shape and form* (a rope light follows one side), and is a *shape that resists straight lines*.

This play room has an above average rating for each of the first four elements, which includes the attributes discussed above and is slightly below average in the remaining two elements of *Place-based relationships* and *Human-nature relationships*. While offering above average access to *Environmental features* with color, water (sink), natural materials (wood furniture), and views and vistas (the eight floor location offers a view of the surrounding wooded area), these attributes are dominant features in the room alongside of *Light and space*. The element *Light and space* includes *natural light*, which is seen in the large expanse of windows across the entire back wall. The size of the windows allows for maximum daylight penetration into the relatively deep interior of the play space. The repetitive use of the curved soffit throughout the space and the overall singular open space increase spatial harmony; the angled changes in the room width help define spaces within the room. With the ceiling height changes, room width modification, and various other design features the attribute *spatial variety* is created.

Variety in the attributes present extends to the moveable storage modules that aid spatial definition. These modules also offer biophilic features such as defining a *transitional space* at the doorway and *dynamic balance and tension* (through the curved and varied materials on the top of

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the module). These modules offer the ability to define space and allows for varieties of activities

to be facilitated in the room in a fluid manner throughout the day if necessary. The mobile cart at

the entrance creates a spatial division upon entering the space and creates a small play area with

mirrors appropriate for infants. The use of tables and chairs also supports a diversity of activities.

The variety of attributes present adds greatly to the perception of the space as somewhere you

want to enter and explore, while the survey showed that if the space could be larger (probably

wider) it would be able to accommodate more patients at more age levels at the same time, further

supporting the mission of Child Life.

Play Room #19

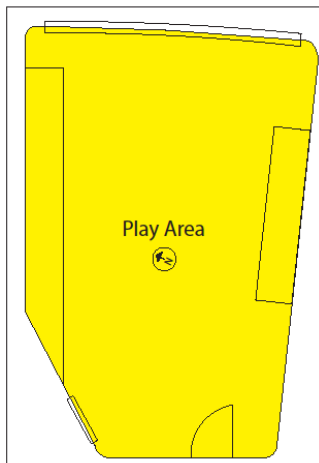Levine 9th floor Play Room

Figure 64. Levine 9th floor Play Room Plan. Not to scale.

Figure 65. Levine Children's Hospital 9th floor Play Room. Photo credit- author.

Figure 66. Levine Children's Hospital 9th floor Play Room. Photo credit- author.

The 9th floor play room at Levine is their only space not offering a built-in computer area. Otherwise, the other floors offer similar spatial definition and features. One additional

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differentiation among the play rooms is the use of color and a coordinating metallic fleck colored glass window insert. The glass connects the space to the elevator lobby area and each floor is color coordinated, with the 8th floor being yellow and this floor featuring lime green. According to the survey, the variety of toys/games and the ability to socialize are the main benefits that families find in using the space. The problem with toys going missing is a concern for most play rooms and results in a difficulty for Child Life to keep a range of age appropriate toys in the play rooms. Aiding with coping, which play rooms provide, is assisted with the different zones created with the mobile carts and allows for multiple activities to occur in the space at the same time. The low height of the carts offers the staff visual access to be able to supervise the entire room easily. The addition of the window wall allows for views of the surrounding treetops and increases the lighting in the room. Each of the four similar play rooms scored above average on the *Light and space* category with the aid of the windows and unique spatial features. These four spaces also all scored above average on the first four elements. They scored just around the average mark on the last two elements and so overall their scores reflected a broad range of distribution of the attributes among the elements and a resulting above average total score. The modern style design features are designed to stay new looking and resist wear and all of the spaces do not include the *age, change, and the patina of time* attribute. There is also a lack of *historical connection to place* and together, the space feels no connection to the past, but the newness of the space is appealing and creates the feeling of a clean (and maybe perceptively a safer) environment.

Some challenges with this space include that this and the other play rooms are not open to patients on contact precautions and so does not offer any benefits to this patient group. The

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desire to accommodate them safely with a larger room full of kids is not able to be accomplished

here. The additional challenge of limited staffing for the play rooms could benefit from

increasing the staffing time available for managing materials and the running of the play room.

More staffing of the play room for evening and weekend sessions was also desired by the

Specialist surveyed. This would expand the benefits of the room to more patients, more often.

<u>*Play Room #20*</u>

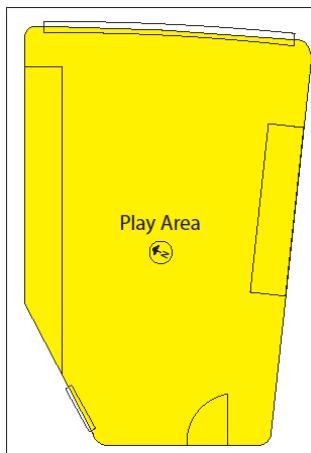Levine 10th floor Play Room

Figure 67. Levine 10th floor Play Room Plan. Not to scale.

Figure 68. Levine Children's Hospital 10th floor Play Room. Photo credit- author.

Figure 69. Levine Children's Hospital 10th floor Play Room. Photo credit- author.

While the 10th floor has similar benefits and challenges as the other similar floors, the addition of a room sponsor represented in the interior design adds uniqueness to this space. The

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Panthers football team is the sponsor for this floor and is seen in the elevator lobby on a plaque as well as the photo image of the player and cheerleader that you can stand behind to have your photo taken inside the play room. This is designed to look like you are the player or cheerleader at the game in front of the stands. The coordinated color for this floor is a medium blue and ties to the colors in the flooring. The use of the blue also supports the color of the sports team's uniforms and provides its own biophilic contribution of *color*.

The survey response for this space was that it is a great area. "There are things that attract to children of all ages and development levels. It is a wonderful area for teaching and therapeutic activities." The survey response also showed the features of the play room supporting Child Life by being an area separated from the hospital that greatly helps patients to cope.

The setup of the mobile carts on this floor in the front area creates a distinct space that uses the smallest of the three different seating heights of chairs with the matching and coordinated tables. They are in each play room and create age appropriate play areas. This space had the highest score of the four play rooms because it used two of the mobile carts up by the door. This set up provides a place to view the entire play space from and the storage unit by the window added a separation from the hallway traffic that adds to the sense of refuge inside the play area from the hospital at large. The use of the sports theme and the stadium photo activity area is a favorite with those people who go on tours of the facility and offers a connection to the local culture, but did not qualify for the *cultural connection to place,* as the definition for this attribute was too restrictive. The above average total scores for all four of the children's play areas in this facility is a trend not duplicated elsewhere.

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Play Room #21

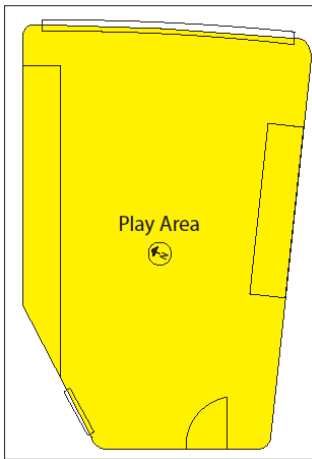Levine 11th floor Play Room
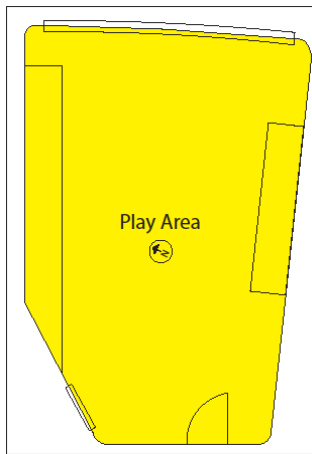
Figure 70. Levine 11th floor Play Room Plan. Not to scale.

Figure 71. Levine Children's Hospital 11th floor Play Room. Photo credit- author.

Figure 72. Levine Children's Hospital 11th floor Play Room. Photo credit- author.

This play room is important, like the others, as indicated in the survey because "playrooms give children the opportunity to play and be kids. Children learn through play and cope with their experiences using play." This floor follows the other floors in most features and uses a brighter blue accent wall color. It also uses the table set up to assist with defining different age appropriate play areas. It has the middle height chairs and tables up front with a puzzle and book supply in a mobile cart and book shelf. The rest of the room is set up similar to the other floors with a large screen TV and banquet seating between the windows and sink, a computer area, and large storage wall. The rear of the room by the windows is divided in half by a mobile cart for an area by the TV and video games and an area by the art supply nook. This nook includes wall mounted paper supplies and storage cabinets with a countertop under the windows. There is a lack of a transitional space by the entry, but there is an addition of botanical motif

decorations present on the built-ins. The above average number of biophilic variety in the space is complemented by a space that the Specialists find that families really appreciate.

Play Room #22

Levine 11th floor Teen Activity Room

Figure 73. Levine Teen Play Room Plan. Not to scale.

Figure 74. Levine Children's Hospital Teen Activity Room. Photo credit- author.

Figure 75. Levine Children's Hospital Teen Activity Room. Photo credit- author.

The teen room at Levine is in process of getting funded for renovation and is a lot smaller than the other play rooms that are in the facility. The space does offer some spatial variety in the room layout and ceiling details and also offers a few different play zones. The window adds day lighting and a view of vegetation, while allowing the light to bounce off the white wall. The wall color against the darker flooring adds *complementary contrast,* but is not balanced with visual interest in the room to make the contrast more harmonic. A lack of a *central focal point* that could provide some of that visual interest is not present to assist with a sense of organization. The lack of spatial harmony due to its discordant design could be aided by thematic use of color, pattern, and/or a design theme. One of the design issues seen is the lack of space for the activities desired in the room. The use of the room would benefit from some attention to the wall surfaces and decorating the room appropriately for a teenager with more nature representations, for example the use of natural and indigenous materials. Since the present room is being partially

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used for storage, additional storage in the room could be beneficial. Also, the cleanability of the features in this room is very important to think about before the next renovation takes place. According to the survey, Child Life is required to clean their play rooms. Limiting the time that the Child Life staff spends on cleaning adds to the time they can spend with the children and optimizes the safety of the play environment.

Play Room #23

Jeff Gordon Teen room
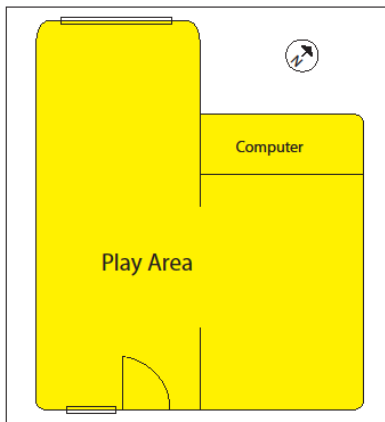
Figure 76. Jeff Gordon Children's Teen Room Plan. Not to scale.

Figure 77. Jeff Gordon Teen Internet Cafe. Photo credit- author.
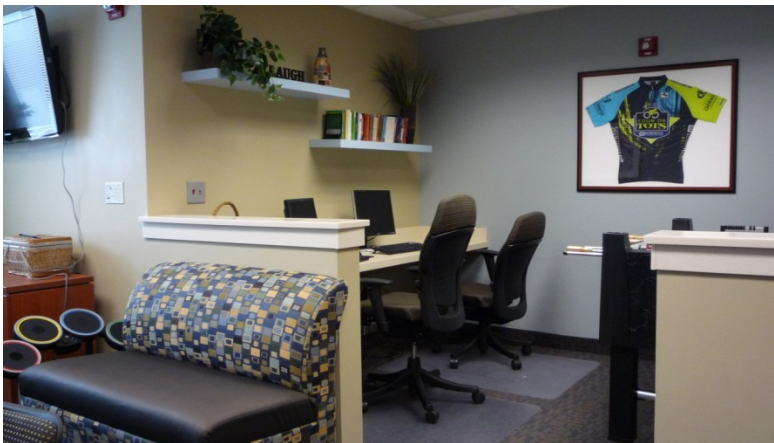
Figure 78. Jeff Gordon Teen Internet Cafe. Photo credit- author.

This is the teen room for Jeff Gordon's Children's Hospital and scored a mix of above and below average scores among the various biophilic elements being measured. This room was recently renovated with design input from the Child Life Specialist. The survey response states that the room "provides teen patients with a place to go to get out of their room and enjoy time with other patients, friends, or family." The room offers a day lighted TV/game lounge area featuring wrap around seating, as well as a computer area and foosball table. This room "serves

it's purpose in our department. When we have patients 13 years and older, they are hesitant about coming into the playroom and with the teen cafe they have another choice. The boys really enjoy the game systems while the girls tend to use the computers. There is also a table for crafts if they would like." The table for crafts and the large seating area allows family and friends to participate in the lounge area together with the patient. While the location is a little hard to monitor, the space was requested in the survey that it "would be nice to have some music playing. I also feel like when we are able to get cameras for our EMU monitoring services, and those patients are able to join us in that space it will be wonderful." Adding music would increase the sensory variability and the safety features would allow more patients to benefit from the space. The biophilic features that are present are seen in more adult-like versus child-like designs that are even found in the decorative accessories in this room. This room offers a space that feels more teen appropriate than child-like, while still offering a variety of biophilic features.

Jeff Gordon Play Room
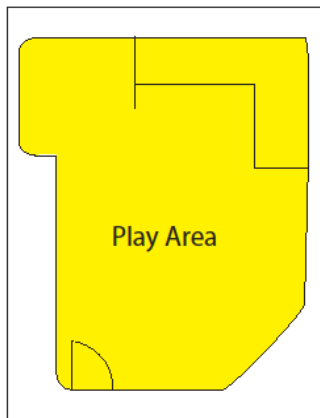
Figure 79. Jeff Gordon's Play Room Plan. Not to scale.

Figure 80. Jeff Gordon Children's Play Room. Photo credit- author.

Figure 81. Jeff Gordon Children's Play Room. Photo credit- author.

The main Child Life play room at Jeff Gordon has a large custom glass window wall that views the hallway and has a tree patterning. The room itself has a small semi-divided area for floor play, a larger space with tables and built-ins that includes benches and storage along the windows, plus closed cabinetry along two other walls. A main complaint for the space that was revealed in the surveys was the glass wall faces the inside of the hospital with no windows within view and there are no windows in the play space either. The preference for access to an outside space if only through windows including daylight would greatly benefit the moral of the patients and staff, according to the survey. Also, the furniture and built-in storage in the space is not sized for pediatric patients, including only an adult height sink that has led to attempting dangerous climbing by patients. The tables and seating area is too small and the room not large enough to have many patients with IV poles at once. In fact the survey showed that four patients in the play room required they be positioned separately among the two tables and resulted in reduced patient interaction, which is a desired socialization method for coping in the hospital setting.

The location of an adjacent storage room in the play room allows for quick access to art supplies, movies, and musical instruments and aids in the play room sessions running smoothly, but accessible storage for school age children was limited and has led to their reduced use of the play room. The color scheme was another feature that could be modified with replacing the laminate and carpeting (the carpeting was seen as not sanitary in the survey) and this could be further incorporated into a theme with decorations that integrated the glass wall tree design. The integration of the survey requests for greater biophilic attributes by the Child Life Specialist, as well as their request for greater attention in the design of the furniture and design features for patient anthropometrics, would increase this space's ability to maximize the patient benefits from Child Life and from the play room.

Findings

The inclusion of biophilic attributes in the spaces that were surveyed was found in varying amounts among each location. The variety of recurring themes found in the surveys was further reinforced with the matrix results in the case studies. The case studies showed a link between the environment and the perceived effectiveness of the spaces by Child Life, with biophilic features adding desired features. There were also a few common issues identified. The dominant need was for more space and found in eleven out of 22 spaces that did not receive credit for being spacious. The biophilic attribute, spaciousness, was present in only two of the spaces and was perceived as either effective or very effective in these spaces. Another half of the remaining spaces that did not respond to needing more space were border line as being defined as spacious, so they might not feel the need for more space compared to other priorities. The decision to include a space as spacious was based on Kellert's explanation of spacious being a

feeling of openness, especially with sheltered peripheries and is often encountered in spaces such as airports and train stations. This definition aided in limiting the attribute to spaces that had a sense of openness through expanded width and height, especially when a sense of enclosure was nearby. The need for more space is explained by many of the survey responses as the need to accommodate more patients, which relates to floor space. The need for space allows patients with equipment to be able to easily access multiple activities and have opportunities for socialization to occur, while allowing staff and volunteers to access the activities and provide the interactions needed. This does relate to the special presence a spacious room has, as it offers the floor space and a special overall grandness that relates to larger natural-occurring outdoor spaces.

A broader sense of what could be defined as historic, ecological, and cultural could support adding items to the interior that serve the spirit of these attributes, but do not satisfy the current definition. The cultural connection to place says it is the geographic, historic, and ecological connection, thus if you had all three of these present in the space you also received credit for ecological connection to place. This definition should be modified to include references to the local culture, like local art, music, athletics and other philanthropic organizations that may be represented in a space, but cannot receive credit under the current definition.

Attributes were not included as present if they were located outside of the play room, for example a historical plaque near the outside of the entry door was not included. The larger context that one experiences when passing through a building is not limited to the interior of a particular room, but is connected among all of the spaces one experiences on the way to the space. This was a scope too large for this project to include, but is an important biophilic

incorporation that can increase the buildings continuity by weaving biophilic elements throughout the building.

Product design was another area of interest found in the case studies. The need for anthropometric patient supportive design features in the interior was another major need and cause for further product design development in the future, including the specification or design of pediatric specific furniture. The preference for adjustability in the heights of the tables and chairs, for example, assists with adjusting to varying patient needs. Just as a majority of the patient room's furniture adjusts, so should many of the play room's furniture. Another key finding was the fact that some design features represented multiple attributes and became a benefit for higher biophilic variety. An example of this was the modular units found in Levine Children's Hospital that were: made of wood and other varying tactile materials, had curvalinear lines, multiple colors, and biomorphic features. Designs like this allow for great biophilic variety to occur in one feature. This could be further tested with additional research regarding the benefits for incorporating more biophilic variety within single products. This offers great opportunities for product design to add biophilic variety to the interior environment.

The lowest effectiveness ratings from the survey responses were found in spaces scoring on the lowest end of the matrix results and further support a link between an environment with a higher variety of biophilic attributes and an effective Child Life play space. The apparent appeal that spaces with diverse biophilic attributes had suggests that biophilic presence deserves further research. This includes research on the individual attributes and wider application of the matrix for other types of environments for indicating greater trends. The matrix is easily adaptable for adding or subtracting attributes for customized use and additional research possibilities can

continue to add to this initial operationalization of biophilia. It also can lead to finding more research-based evidence for incorporating biophilia into play rooms and other interiors.

Delimiters

Assessment of the limitations of a study is important. The delimiters of this study include not assessing the overall larger healthcare building industry; neither were other pediatric areas within hospitals, nor outdoor play spaces investigated. The focus on interior play spaces came from the need for perceived biophilic presence and definable spaces, as well as a desire to add research support to interior play spaces that are not as research saturated.

One question that needs further research support is if the elements and attributes listed are extensive and correct as stated. The lack of prior research specifically of biophilia in regards to the interior has been a central challenge and became a central reason in support of pursuing this work. The challenge with the use of the design elements was their lack of extensive research supporting each of them conclusively, but abundant support coming from a growing body of related disciplines and professions makes it at least a worthy hypothesis. The applicability of these design elements in the Child Life setting was cause for this research as well as a potential for finding both strengths and shortcoming to the relevancy for each of the attributes. This was partly addressed by the clarification and exploration of each attribute in this research and served to provide support for new interior biophilic design research addressing each attribute more fully. It would be a lengthy process to measure each element individually and perhaps in combination, but this research provides a starting point for further exploration of this topic.

There may be some economic and geographical uses of the attributes that may be un-represented by the focus on North Carolina for the study. Contra indicators for the preferences of the space like life safety issues such as sterilization that are not biophilic were present in some of the Child Life surveys and opens up additional specific design needs for future research. Additional research could also add the human element of the care givers role in the supportiveness of the environment, as well as observing children's influence on and influence within the environment to further broaden the research.

The case studies revealed a lower level of teen play room biophilic incorporation, as if while we go toward adult hood the use of nature is not as appropriate. The use of more sophisticated and less child-like biophilic attributes is achievable, as found in several of the design features in the teen rooms surveyed. The use of natural baskets as design features for example brings *natural materials* and *shapes resisting straight lines.* While not needing to have a picture of an elephant on it, this can bring more adult-like nature-based design features into a space. Another example would be the use of the mirror art in the teen space at Vidant Medical. This feature offers *reflections* of light, *shapes resisting straight lines*, and *fractals.* It looks appropriate for teens or adults and increases the biophilic variety with less of a traditional nature-theme that may come to mind when initially thinking about adding biophilia to a space. These case studies can serve as points of reference and inspiration for designing teen spaces in the future. A chart for visually displaying the differences in the scoring of the teen rooms and children's play rooms demonstrates the scoring variance and is seen in Figure 82.

N.C. Child Life Teen and Children's Room Comparison

■ N.C. Child Life Teen Play Rooms   ■ N.C. Child Life Children's Play Rooms

Biophilia Matrix
Scores
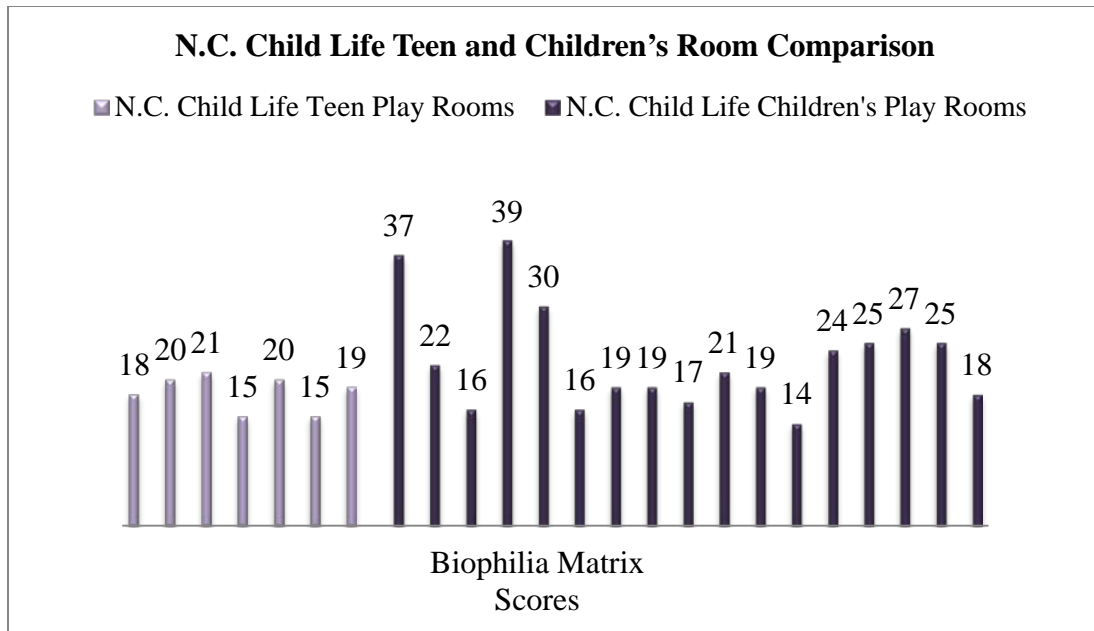
Figure 82. N.C. Child Life Teen and Children's Play Rooms. These are separated and ordered according to order of sites visited.

This finding indicates a need for further research directed specifically at teen rooms and the distinct needs of these types of space that are required for this specialized user group.

The small number of inter-rater reliability measures performed may reduce external validity, however the use of designers with diverse specialties and back grounds aids in generalizability of the matrix instrument aimed for use by designers. The average rating comparison results served to demonstrate the overall reliability of the measurement tool. The outcome of a tried and tested instrument, as well as the compilation of other data and results from this research can now be open for future research to build upon.

CHAPTER V

CONCLUSIONS

In regards to the research questions, a variety of biophilic elements and attributes were able to be found in the interior of Child Life play spaces. The perceptions of the Child Life Specialists regarding the interior design specifically expressed some desires for biophilic features. The results of the matrix scores showed that generally the spaces were seen as effective.

This research aids in supporting additional research regarding Child Life and biophilia. It includes: 1) highlighting the importance of designing play spaces, 2) the need for inclusion of biophilic design features in play spaces, 3) the wider application of the biophilic design attributes, case studies, and the use of the biophilic design matrix.

The first broader application for this research is fueling the conversation in the design community surrounding the importance of Child Life play rooms. These case studies further explored current play room design which offers the photographic library of biophilic examples and the ratings of the North Carolina's inpatient play spaces for developing new designs and design guidelines. These guidelines could involve using the biophilic matrix as a design tool to assist with biophilic identification in Child Life play spaces. This could extend to general biophilia design guidelines for all spaces.

The second application is to promote further research on each of the biophilic elements for general application and specifically how their use in Child Life play room design could assist

with the safe, wide-spread inclusion of biophilic design for positively influencing the patients, family, and staff. Also, there needs to be further research into exploring the exhaustiveness of Kellert's (2008) proposed biophilic design attributes for interior application. Additional research can develop with the data from the beginning quantification and case studies in this research that showed the lowest effective ratings were lower scoring. Monetary and administrative support in the healthcare setting are just a few of the hurdles that increasing the variety of biophilic presence in the interior faces, but research supporting biophilic incorporation and increased effectiveness can be conducted that relates it to the bottom line and aids with integration.

The third application is promoting the inclusion of the biophilic attributes by arming designers with the case studies and the matrix as a tool for biophilic identification. Identification of the attributes in this research required the development of the design matrix, but was also developed with a broader aim in mind. It is easily adaptable to further assist designers and researchers in creating a sort of checklist for identifying and including biophilic features in any interior. However, "a checklist can never assure that even a well-intentioned project will produce a harmonious and beneficial design. Like all great constructions, the whole always remains more than the simple addition of its parts" (Kellert & Heerwagen, 2008). It is the human combination of these elements that ultimately speaks to the success of a design. Thus the job of the designer is to use biophilia to help guide that process and aid in creating spaces that connect us with life.

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APPENDIX A

DEFINITION OF TERMS

Active interaction is immersive contact with nature.

Biophilia is the innate tendency to focus on life and lifelike processes (Wilson, 1984, p.4)

Biophilic design is emphasizing the necessity of maintaining, enhancing, and restoring the beneficial experience of nature in the built environment (Kellert, 2008, p. 325).

Biomimicry is from the Greek bios, life, and mimesis, imitation. The use is included within looking to nature as a model, as a measure, and as a mentor in Janine Benyus' book "Biomimicry: innovation inspired by nature" (Kellert, 2005, p. 52).

Daylight is the light of day with direct and indirect light included not filtered or diffused in the interior.

Environmental features: "The first and most obvious of the biophilic design elements is environmental features, involving the use of relatively well-recognized characteristics of the natural world in the built environment. Twelve attributes are identified…"(Kellert, 2008, p. 6).

Evidence-based design "uses the best, most credible data to impact the design decisions made and is premised on three assumptions: first, patients should be able to devote their energies to healing and recovery without having to cope with an unsupportive built environment; second, healthcare providers should be able to perform their duties without becoming ill themselves or being injured due to an unsupportive built environment; and third, non-carbon-reductive and high

energy consuming buildings for healthcare are tantamount to an unsupportive built environment" (Verderber, 2010, p. 169).

(Evolved) Human-nature relationships: "The sixth and final biophilic design element is evolved human-nature relationships. The term is somewhat misleading, as all the described biophilic design elements presumably reflect biologically based human affinities for the natural environment. The attributes describes in this section, however, more specifically focus on fundamental aspects of the inherent human relationship to nature. Twelve attributes are described, the last eight of which are derived from a typology of environmental values developed by the author and described elsewhere [Kellert 1996, 1997]" (Kellert, 2008, p. 13).

Light and space: "A fourth biophilic design element is light and space. Twelve design attributes… [with] seven focusing on qualities of light and five focusing on spatial relationships" (Kellert, 2008, p. 11).

Nature-deficit disorder is not a medical condition but the human cost of "alienation from nature, among them: diminished use of the senses, attention difficulties, and higher rates of physical and emotional illnesses. The disorder can be detected in individual, families, and communities. Nature deficit can even change human behavior in cities, which could ultimately affect their design, since long-standing studies show a relationship between the absence, or inaccessibility, of parks and open space with high crime rates, depression, and other urban maladies" (Louv, 2008, p. 36).

Natural patterns and processes: "A third biophilic design element is natural patterns and processes. This element emphasizes the incorporation of properties found in nature into the built

environment, rather than the representations or simulations of environmental shapes and forms. Fifteen attributes have been identified and are described…, although this complex element is likely to be altered in the future with additional understanding" (Kellert, 2008, p. 9).

Natural shapes and forms: "The second biophilic design element is natural shapes and forms. This element includes representations and simulations of the natural world often found on building facades and within interiors. Eleven attributes are associated with this design element…" (Kellert, 2008, p. 8).

Passive interaction has no direct contact with the natural item or process.

Place-based relationships: "A fifth biophilic design element is place-based relationships. This element refers to the successful marriage of culture with ecology in a geographical context. The connection of people to places reflects an inherent human need to establish territorial control, which during the long course of our species' evolution, facilitated control over resources, attaining safety, and achieving security. Locational familiarity—the yearning for home—remains a deeply held need for most people. Eleven attributes of place-based relationships are described, the last (placelessness) being the antithesis of the others rather than a stand-alone attribute" (Kellert, 2008, p. 12).

Positive affect (positive emotion or affect) are feelings that reflect a level of pleasurable engagement with the environment. High PA is composed of terms reflecting enthusiasm, energy level, mental alertness, interest, joy, and determination (Clark, Watson, & Leeka, 1989).

Restorative environmental design combines low environmental impact and biophilic design, while restoring the positive connection between nature and humanity (Kellert, 2005, p. 165).

Site is the geographical boundaries of the land the building is on.

Vernacular design is "the tailoring of the built environment to the particular physical and cultural places where people live and work" (Kellert, 2005, p. 165).

APPENDIX B

NORTH CAROLINA CHILD LIFE LOCATIONS

Table 2. North Carolina Child Life Locations.

NC Facility Name	Location	# Inpatient Play rooms
Brenner Children's Hospital	Winston Salem	4
Duke Children's Hospital	Durham	1
Jeff Gordon Children's Hospital	Concord	2
Levine Children's Hospital	Charlotte	5
Mission Children's Hospital	Ashville	2
N.C. Children's Hospital	Chapel Hill	5
New Hanover Regional Medical Center	Wilmington	1
Presbyterian Hemby Children's Hospital	Charlotte	2
Vidant Children's Hospital	Greenville	4
WakeMed Health and Hospitals	Raleigh	1
Total		27

APPENDIX C

CHILD LIFE SPECIALIST SURVEY AND RESPONSES

SURVEY

Child Life Play Space Design Survey

What is the study about?

The Child Life Specialists who are specifically knowledgeable about play spaces are being asked to complete a survey regarding design elements in the inpatient play space(s).

What are the dangers to me?

The Institutional Review Board at the University of North Carolina at Greensboro has determined that participation in this study poses minimal risk to participants. If you have any concerns about your rights, how you are being treated or if you have questions, want more information or have suggestions, please contact Eric Allen in the Office of Research Compliance at UNCG toll-free at (855)-251-2351. Questions, concerns or complaints about this project or benefits or risks associated with being in this study can be answered by Dr. Anna Marshall-Baker, who may be contacted at (336) 256-0307.

How will you keep my information confidential?

No identifying information will be disseminated and all information obtained in this study is strictly confidential unless disclosure is required by law. Absolute confidentiality of data provided through the Internet cannot be guaranteed due to the limited protections of Internet

access. Please be sure to close your browser when finished so no one will be able to see what you have been doing. Your participation (or non-participation) will in no way affect your academic standing or employment status.

Voluntary Consent by Participant:

By filling in today's date below you agree that you have read this form or that it was read to you, you fully understand the contents of this document, all your questions concerning this study have been answered, and you willingly consent to participate in the study. By continuing with the survey you also agree that you are 18 years of age or older and voluntarily agree to participate.

Alternate Voluntary Consent by Participant (for Carolinas Healthcare):

By completing this survey you are agreeing that you read, or it has been read to you, and you fully understand the contents of this document and are openly willing consent to take part in this study. All of your questions concerning this study have been answered. By continuing with the survey you are agreeing that you are 18 years of age or older and agreeing to participate.
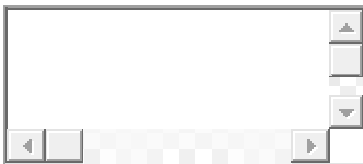
The survey questions follow:

Q1- Write the name of your facility and the name or room number of the Child Life play room you are addressing in the following questions.
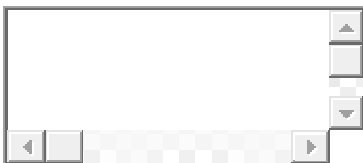
Q2- How effective is the space in its support of Child Life? Please briefly explain your reply.
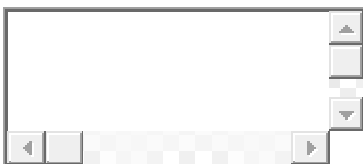
Q3- What aspect of the space best supports Child Life? Please briefly explain your reply.

Q4- Are there aspects of the space that impede Child Life? Please briefly explain your reply.

Q5- If you could change anything about the space, what would it be and why?

SURVEY RESPONSES

A complete list of the survey responses is shown below in Figure 83-87. Note that the Qualtrics

software does not offer spell check.

Table 3. Survey Responses for Question 1.

Facility/ Play Room	Order Visited	Question #1 Responses
New Hanover Regional Medical Center Play/Activity room	#6	It is a beautiful space with an aquarium, open space and a sand castle for younger children, my office with musical instruments(to be used when supervised), and a teen space. The environment, lighting and design are wonderful, the teen side needs more resources and different furniture to make it more appealing to the older children. We also could use a sink. We do have hand sanitizer dispensers but a sink would be more effective for art work.
Vidant Children's Hospital; 3	#14	Extremely; supports the mission and vision of Child Life profession and the hospital.
Vidant Children's Hospital- Playroom/Teen Lounge	#14/15	Playroom- I think that it is very effective. The room is big enough for mulitple pts and family members. We often bring pts in their bed and there is plenty of room. There is a large varity for toys, games and crafts for pts. We also have mulitple tables and two that adjust up and down to fit wheel chairs. / / Teen Lounge- There are a good amount seats and activites to do. A bed could fit along with a couple other people.
Brenner Children's Hospital - 8th floor playroom	#12	Very effective - it is large enough to accomodate patients birth - 11 and some Teens- it is separated for Infant/Toddler toys and playspace and Preschool/School age toys, games, crafts and play space
Brenner Children's Hospital. 6th floor playroom	#10	The playroom is bright and cheerful. You do not feel like you are in a hospital.

NC Children's Hospital Rm # WH70114	#1	It is effective for the purposes we need it for, such as being a safe play that the children can go, stimulates interactive play, family centered, relaxing area, area designated for toddler development, etc. However, it could definitely be more effective, thus the upcoming renovations that are planned. The structure in the center of the room is more effective for "better feeling" children or for use in the community. It is not safe for IV poles and therefore makes it very frustrating to those that cannot go up the ramp. We plan to make the area more family friendly for a larger age range of children.
Duke Children's Hospital room 5248	#9	We do not have enough space to serve the needs of various age levels. The room is very small and we have to provide space for Child Life equipment, toys and supplies, as well as provide a play space to accomodate patients ages 0-18yrs. In addition, a Child Life staff member has her desk space in the back of the playroom.
Brenner Children's Hospital 9the floor Hematology/Oncology Playroom	#13	The space is as effective as it can be considering the limites amout of space.
Vidant Medical, NICU sibling room	#16	The room is a great room to prepare siblings for their first visit. Also a great space for the siblings to be kids by playing with toys, interacting with others, and also engage in theraputic activities.
Vidant Medical Center- NICU Sibling Playroom	#16	While the space is very small, it allows us to do sibling preparations, medical play and therapeutic activities. It also allows the families to be in close proximity to all of their children.
Vidant Medical Center, Pediatric Rehabilitation Playroom	#17	Our playroom is not used as atraditional playroom, but more of a 1:1 or group therapy space. Children do come in for 1;1 or group free play sessions, but these are scheduled and not available all the time. Our unit is small and our dining area is open 24/7.The playroom also serves as a teen lounge were children 11-18 can come in without a staff memeber to get on the computer aor play games/do art at the table. This is the only time the playroom is open for free play. I would love to have a room designated for just play time, but our unit is too small we have to use our rooms for therapy and play time.

Brenner Children's Hospital Teen Room - 1	#11	When sitting on the design committee, I recommended a larger space to accomodate multiple pts with i.v. poles, beds, and wheelchairs. Facilities Planning gave 20 sq feet more, but still not a large enough space to accomodate teen activities, i.v. poles, and wheelchairs. Have created a lounge area with tv and video games, a pool table area, a craft/puzzle/board game area, and a computer area, but very cramped space. It was effective to have teen room placed by the nurses station to have better monitoring of the space. The initial space was very drab, a dark green wall, a white wall, and dark green cabinet with mint green doors.
Jeff Gordon Children's Hospital, Inpatient Play Room	#24	This play room is a large size in general but the space is not utilized appropriately. Shelving is not adequate, and seating for patients is not appropriate or easily accessable when tugging an IV pole and oxygen tank. There is a sink, which is helpful, but it is not at the right height for children, so when not being supervised by staff, patients often times climb on a chair to wash their hands. One of the biggest downfalls of our playroom is that it is on the inside walls of the hospital with no windows in sight. We do not have access to outside space for our patients, so having windows and natural light would be a major uplifter for both patients and staff.
Levine Children's Hospital - 8th floor Playroom	#18	The space is very effective in its support of Child Life. It has lots of things that attract to different age levels. It also is a great area to support our medical play and medical teachings to patients.
Levine Children's Hospital 10th floor Playroom	#20	I think the 10th floor playroom is a great area. There are things that attract to children of all ages and development levels. It is a wonderful area for teaching and therapeutic activities.

Levine Children's Hospital 8th Floor Playroom	#18	The space as far as size goes is an effective space. The 8th floor playroom has areas designed to serve children of all ages and therefore this supports Child Life's all inclusive approach in including children and their siblings that range in their developmental and physical needs. The Child Life Staff has ample amount of space to initiate group medical play sessions, therapeutic play experiences, as well as other interventions needing to take place in a playroom setting. We have storage space to keep specialized materials for these interventions as well as a locked area designated for cleaning supplies.
Levine Children's Hospital, playroom on floors 8, 9, 10 and 11	#18-22	child life operates and manages/cleans all playrooms. Families are really appreciative of the space and opportunity to use toys/games/socialize with other families. It is difficult to keep a variety of age appropriate toys. Often toys are stolen which is costly.
Jeff Gordon Children's Hospital Child Life Teen Cafe	#23	The Teen room serves it's purpose in our department. When we have patients 13 years and older, they are hesitant about coming into the playroom and with the teen cafe they have another choice. The boys really enjoy the game systems while the girls tend to use the computers. There is also a table for crafts if they would like.
Presbyterian Hemby Children's Hospital - Blume Playroom and Teen Room	#7-8	These spaces are xtremly effective in helping provide normalization opportunities for all age ranges of our patient population.
UNC Hospitals- NC Children's Hospital	#2-5	Game Room- allows for gross motor activities/therapies; games that allow more than 1 person to play thereby creating a social environment for peer interactions / Teen Lounge- space just for teens; encourages social/peer interactions; space to cook to create a feeling of normalcy / RT Room- mirrored space for working with infants/toddlers; extra space to use of isolated children / Music Room- provides an outlet expression of emotion

Table 4. Survey Responses for Question 2.

Facility/ Play Room	Order Visited	Question #2 Responses
New Hanover Regional Medical Center Play/Activity room	#6	Having enough space for independent play and space for when working with Child Life staff
Vidant Children's Hospital; 3	#14	Play, normalization, diversion, education, creativity, non-threatening, and exploration
Vidant Children's Hospital- Playroom/Teen Lounge	#14/15	Playroom/Teen Lounge- The open, friendly, and fun/cool atmosphere. Also that it is a procedure free zone.
Brenner Children's Hospital - 8th floor playroom	#12	It provides a safe environment for all age patients from medical procedures and it normalizes their hospitalization. It provides the opportunity for soicalization and to have oppoprtunities for developmental and therapeutic play activites.
Brenner Children's Hospital. 6th floor playroom	#10	The playroom provides opportunities for play and expressive activities to encourage normal development and a sense of fun in spite of challenging circumstances. The playroom has play centers and a wide range of art supplies. The room helps normalize the hospital experience.
NC Children's Hospital Rm # WH70114	#1	Safe, family-centered space. No one is allowed to come into the room to do anything "medically related" to the child. This includes listening to a heart beat, looking at a wound, or talking about an upcoming surgery. All of these things must be done outside of the room.
Duke Children's Hospital room 5248	#9	The large round table that we have does accomodate several children at a time when doing a group activity. Our shelves are also at a child's level to be able to easily access toys.
Brenner Children's Hospital 9the floor Hematology/Oncology Playroom	#13	We have utilized the shape of the room to create age appropriate sections with in the small space

Vidant Medical, NICU sibling room	#16	Room to do one on one sessions with siblings or group activites. The sessions are a great way to help siblings understand what is happening with their siblings and also prepare them for visits in the unit.
Vidant Medical Center- NICU Sibling Playroom	#16	We have several cabinets in the space that hold all of our supplies for anything we may want to do with the siblings.
Vidant Medical Center, Pediatric Rehabilitation Playroom	#17	There are no medical procedures done in the room, children participate in medical play and medical teaching in the room, expression of emotion activites and treatment sessions are done in the room, developmental play is facilitated in the room, social interaction sessions are facilitated, modifications for play are taught, siblings participate in play/education sessions...
Brenner Children's Hospital Teen Room - 1	#11	The various spaces created offer teens the opportunity to have control to choose what activity they want to do. Control is a huge issue for teens, who lost control when hospitalized. It also brings normalizing activities that they may do at home to assist with their coping to hospitalization and offers socializing opportunities for teens with peers which is very important to a teen.
Jeff Gordon Children's Hospital, Inpatient Play Room	#24	We have a large (but not large enough) walk-in storage closet in our playroom where we are able to keep all of our art supplies, movies, and musical instruments. This is nice to be able to get things quickly when running playgroup.
Levine Children's Hospital - 8th floor Playroom	#18	The tables and chairs support what we do as Child Life specialists. They get to be in a comfortable environment to them which makes it easier for us to help support their needs.
Levine Children's Hospital 10th floor Playroom	#20	The idea of a playroom in general. One of our jobs is to normalize their environments, and I think having a area to separate themselves from the hospital feels help them to cope greatly.

Levine Children's Hospital 8th Floor Playroom	#18	The large open play area but also the ability to recreate areas to meet the needs of the children depending on their developmental level. A hospital playroom compared to a day care playroom for example must be able to have flexibility, space, and should be inviting to children. I feel that with our dividers it provides us with the ability to change the structural setting depending on the needs of the kids. In the next couple of weeks the 8th floor playroom will have a "medical play area". We have ordered materials and child sized equipment including (MRI machine, CT Scanner, Treatment room table, etc) and will have a space where children can reenact medical experiences they have had. I would say this best supports Child Life once we get equipment in at the end of the month.
Levine Children's Hospital, playroom on floors 8, 9, 10 and 11	#18-22	The playrooms give children the opportunity to play and be kids. Children learn through play and cope with their experiences using play.
Jeff Gordon Children's Hospital Child Life Teen Cafe	#23	It provides teen patients with a place to go to get out of their room and enjoy time with other patients, friends, or family.
Presbyterian Hemby Children's Hospital - Blume Playroom and Teen Room	#7-8	It provides safe spaces for normative play and age appropriate developmental opportunities while children are hospitalized.
UNC Hospitals- NC Children's Hospital	#2-5	Each room allows for group interactions and 1:1 therapy; the rooms are also "safe zones", so no medical anything can take place in the rooms

Table 5. Survey Responses for Question 3.

Facility/Play Room	Order Visited	Question #3 Responses
New Hanover Regional Medical Center Play/Activity room	#6	No sink is a minor setback
Vidant Children's Hospital; 3	#14	Limited teen lounge space minimizes full potential

Vidant Children's Hospital- Playroom/Teen Lounge	#14/15	Playroom/Teen Lounge- The space suits Child Life's needs and mission.
Brenner Children's Hospital - 8th floor playroom	#12	We have non-clinical job responisibilites that are necessary to provide an area that meet Infection Control and Safety Stndards. This can result in less time with patients. The assistance of volunteers helps.
Brenner Children's Hospital. 6th floor playroom	#10	No
NC Children's Hospital Rm # WH70114	#1	The flooring in the Play Atrium is made of recycled tires and very difficult to clean. It is quite porous so children receiving chemotherapy are not allowed on it because if the chemo were to spill, it would not be able to be cleaned up and the floor would have to be cut out.
Duke Children's Hospital room 5248	#9	The entire room is too small. We do not have enough floor space for patients who come down in wheelchairs with IV poles and still have enough spsce for infants and toddlers to be able to roam. It can be a very dangerous area at times when there are too many people plus equipment in the room.
Brenner Children's Hospital 9the floor Hematology/Oncology Playroom	#13	The size greatly impedes what could be done. The room serves inpatient and outpatient patients and their families. This can create a very crowed space.
Vidant Medical, NICU sibling room	#16	no
Vidant Medical Center- NICU Sibling Playroom	#16	The size of the room is very small, so we are unable to work with many siblings at any one time.
Vidant Medical Center, Pediatric Rehabilitation Playroom	#17	We try not to have this happen, but sometimes families meet in here to discuss no so nice social situations because it is the only private room that is not being used all the time for therapy

Brenner Children's Hospital Teen Room - 1	#11	The space is an issue. It is a small space and sometimes kids won't come down if too many people due to space. Also, there is no room for a bed to be moved into if a pt. is on bedrest, those kids lose out on that opportunity of change of environment from room and social opportunities.
Jeff Gordon Children's Hospital, Inpatient Play Room	#24	There is not enough space. There is no room to move around and the tables are just too small for effective patient interactions. If there are 4 patients for playgroup, they have to be split between the two tables in order to do the project. Also, the patient's have access to a lot of todder/preschool toys, but the only storage for additional items is too high for a lot of kids to reach. Also, there is not enough storage for essential child life items.
Levine Children's Hospital - 8th floor Playroom	#18	
Levine Children's Hospital 10th floor Playroom	#20	I do not think so.
Levine Children's Hospital 8th Floor Playroom	#18	Some of the structural components make things more difficult. Where the outlets are located, the computer desk takes up a lot of wall space, the door being heavy and children having the ability to be right at the door playing which can be a safty concern on very rare occasion.
Levine Children's Hospital, playroom on floors 8, 9, 10 and 11	#18-22	children on contact precautions can not enter the playroom and this is difficult for the patients and their siblings/families. Toys are often stolen from playrooms which is costly.
Jeff Gordon Children's Hospital Child Life Teen Cafe	#23	The location of the room is a little hard for us to monitor it. However, we often check in with our patients when we know they are in there in order to better serve them.
Presbyterian Hemby Children's Hospital - Blume Playroom and Teen Room	#7-8	No
UNC Hospitals- NC Children's Hospital	#2-5	RT Room- space has decreased (in half) in past year or so due to renovations; not as much room for the children to be active

Table 6. Survey Responses for Question 4.

Facility/ Play Room	Order Visited	Question #4 Responses
New Hanover Regional Medical Center Play/Activity room	#6	I would add a sink and an emergency call button
Vidant Children's Hospital; 3	#14	Enlarge teen lounge so could have more appropriate, interactive teen games and also could create specific areas of support (i.e. quiet area for reading, area for physical activity, lounging space for socialization)
Vidant Children's Hospital- Playroom/Teen Lounge	#14/15	I would love to have more natural light and a door that opens up to a balcony so that pt's can get fresh air and feel the warmth of the sun or play with chalk.
Brenner Children's Hospital - 8th floor playroom	#12	I would like for the playroom to be inside the patient unit to provide a safer playroom. Currently the 8th playroom is outside of the locked unit and near elevators. A Child Life Specialst, Child Life ASsistant or trained volunteer has to be in the playroom at all times when it is open as a safety precaution.
Brenner Children's Hospital. 6th floor playroom	#10	If I could change anything I would increase the size of the room and would get new carpet.
NC Children's Hospital Rm # WH70114	#1	Removing the play structure. Children get quite frustrated when they are not able to go on it if they have an IV pole. Also, the children like to take the bigger toys with wheels and roll them down the slide, which is a safety concern. With the upcoming renovations, it will be removed.
Duke Children's Hospital room 5248	#9	I would start by making it bigger. I would then divide the area into soft and usable space to allow mats and soft areas for infants to have developmental play time. I would redesign an area for computer access for patients. We have over 75 children who could utilize this space if they were medically and physically able to play in the playroom. There is no room!

Brenner Children's Hospital 9the floor Hematology/Oncology Playroom	#13	The size of the room and perhaps lighting choices for a variety of uses. It is difficult for both inpatient and outpatient families to have enought space. many times the inpatients will not come into the playroom until the clinic appointments are finished. I would have a larger separate space for older patients where there are separate from the younger patients. I would also have a separate playroom for clinic patients.
Vidant Medical, NICU sibling room	#16	More cabinets to store items and also more room to have larger groups in the room at one time.
Vidant Medical Center- NICU Sibling Playroom	#16	Enlarge the room to accomodate more adult size chairs and more sibling group activities.
Vidant Medical Center, Pediatric Rehabilitation Playroom	#17	I would have a bigger space, two rooms (one for teens and one for younger kids), I would have a pool table and a music system, in the younger kids area we would have a soft floor, in the teen area interactive video game space; I would have an additional sesion for art with a washable floor and a sink, I would also have an interactive white board...
Brenner Children's Hospital Teen Room - 1	#11	I have changed the space several times from what facilities planning initially did. I changed the walls from dark green and white to yellow, moved out the 2 huge, tall square tables, and brought in 1 lower, rectangular table. I found that the rectanglar table did not work very well b/c sometimes a few pts. may want to do crafts and another play a board game or do a puzzle, so I found it was very helpful to have 2 tables. I have since then found 2 smaller round tables and secured a donation of a mural painted on the wall. The mural is a favorite among pts and families and really makes the room feel open and gives the sense of nature. If I could change the space, I would make it larger and have a window for natural light. I also would add surround sound for music/relaxation music and different lighting, such as LED stars on the ceiling or a dimming light so pts. can control their own environment. This environment would promote positive effective pt. coping. The new Interior Designer for Facilities Planning is in the process of reupholstering the furniture in which she asked input for selections. I am very excited because I (cont.)

		think it will really bring the room together. The materials are earthy browns and will consist of snake skin look and cork look for the craft chairs which looks like tree bark.
Jeff Gordon Children's Hospital, Inpatient Play Room	#24	I would change the colors- the room is colorful but the colors are dull. I think it would be more inviting if we could have a mural or some kind of decorations on the wall. Even just a dry-erase board in an easily-acceesable spot would make it more friendly. Also, the carpet in the room is not sanitary. The major change I would make it add more accessable storage, including open and closed shelving, for school-age patients. This age group does not enjoy coming to the playroom because we don't have the space for school-age items.
Levine Children's Hospital - 8th floor Playroom	#18	I would make it larger in order to make there be more age appropriate areas.
Levine Children's Hospital 10th floor Playroom	#20	I would love to see more development appropriate breakdown of toys within the playroom.
Levine Children's Hospital 8th Floor Playroom	#18	To add more color, more techolocially interactive pieces as this is a current trend for children and a part of their world now more than ever.
Levine Children's Hospital, playroom on floors 8, 9, 10 and 11	#18-22	I would like a paid employee to be in the playroom at all times so materials could be better managed. I would also like the hrs to be extended so it could be open in the evening hrs and weekends.
Jeff Gordon Children's Hospital Child Life Teen Cafe	#23	I think it would be nice to have some music playing. I also feel like when we are able to get cameras for our EMU monitoring services, and those patients are able to join us in that space it will be wonderful.
Presbyterian Hemby Children's Hospital - Blume Playroom and Teen Room	#7-8	No
UNC Hospitals- NC Children's Hospital	#2-5	RT Room- increase the size to allow for gross motor activity for toddlers and younger school age children

Consolidation of the survey answers regarding spatial preferences is shown in Figure 87. Survey spatial preference results.

Table 7. Survey spatial preference results.

#6	It is a beautiful space with an aquarium, open space and a sand castle for younger children, my office with musical instruments(to be used when supervised), and a teen space. The environment, lighting and design are wonderful, the teen side needs more resources and different furniture to make it more appealing to the older children. We also could use a sink. We do have hand sanitizer dispensers but a sink would be more effective for art work.
#14	Limited teen lounge space minimizes full potential
#12	Very effective - it is large enough to accomodate patients birth - 11 and some Teens- it is separated for Infant/Toddler toys and playspace and Preschool/School age toys, games, crafts and play space
#10	If I could change anything I would increase the size of the room and would get new carpet.
#9	I would start by making it bigger. I would then divide the area into soft and usable space to allow mats and soft areas for infants to have developmental play time. I would redesign an area for computer access for patients. We have over 75 children who could utilize this space if they were medically and physically able to play in the playroom. There is no room!
#13	The size of the room and perhaps lighting choices for a variety of uses. It is difficult for both inpatient and outpatient families to have enought space. many times the inpatients will not come into the playroom until the clinic appointments are finished. I would have a larger separate space for older patients where there are separate from the younger patients. I would also have a separate playroom for clinic patients.
#16	More cabinets to store items and also more room to have larger groups in the room at one time.
#16	Enlarge the room to accomodate more adult size chairs and more sibling group activities.
#17	I would have a bigger space, two rooms (one for teens and one for younger kids), I would have a pool table and a music system, in the younger kids area we would have a soft floor, in the teen area interactive video game space; I would have an additional sesion for art with a washable floor and a sink, I would also have an interactive white board...
#11	The space is an issue. It is a small space and sometimes kids won't come down if too many people due to space. Also, there is no room for a bed to be moved into if a pt. is on bedrest, those kids lose out on that opportunity of change of environment from room and social opportunities.

#24	This play room is a large size in general but the space is not utilized appropriately. Shelving is not adequate, and seating for patients is not appropriate or easily accessable when tugging an IV pole and oxygen tank. There is a sink, which is helpful, but it is not at the right height for children, so when not being supervised by staff, patients often times climb on a chair to wash their hands. One of the biggest downfalls of our playroom is that it is on the inside walls of the hospital with no windows in sight. We do not have access to outside space for our patients, so having windows and natural light would be a major uplifter for both patients and staff.
#24	There is not enough space. There is no room to move around and the tables are just too small for effective patient interactions. If there are 4 patients for playgroup, they have to be split between the two tables in order to do the project. Also, the patient's have access to a lot of todder/preschool toys, but the only storage for additional items is too high for a lot of kids to reach. Also, there is not enough storage for essential child life items.
#18	I would make it larger in order to make there be more age appropriate areas.
#2-5	Game Room- allows for gross motor activities/therapies; games that allow more than 1 person to play thereby creating a social environment for peer interactions / Teen Lounge- space just for teens; encourages social/peer interactions; space to cook to create a feeling of normalcy / RT Room- mirrored space for working with infants/toddlers; extra space to use of isolated children / Music Room- provides an outlet expression of emotion

BIOPHILIC INTERIOR DESIGN GLOSSARY

Air- natural ventilation (access to the outdoors: i.e. operable window or door)

Biophilia is the innate tendency to focus on life and lifelike processes (Wilson, 1984, p.4)

Biophilic design is emphasizing the necessity of maintaining, enhancing, and restoring the beneficial experience of nature in the built environment (Kellert, 2008, p. 325).

Biomimicry is from the Greek bios, life, and mimesis, imitation. The use is included within looking to nature as a model, as a measure, and as a mentor in Janine Benyus' book "Biomimicry: innovation inspired by nature" (Kellert, 2005, p. 52).

Daylight is the light of day with direct and indirect light included not filtered or diffused in the interior.

Egg, oval, and tubular forms: often used as design element details and seen in ornament and structural purposes such as columns, molding, and fountains (often found in the use of tubular steel furniture components in the built environment)

Environmental features: "The first and most obvious of the biophilic design elements is environmental features, involving the use of relatively well-recognized characteristics of the natural world in the built environment. Twelve attributes are identified…"(Kellert, 2008, p. 6).

(Evolved) Human-nature relationships: "The sixth and final biophilic design element is evolved human-nature relationships. The term is somewhat misleading, as all the described biophilic design elements presumably reflect biologically based human affinities for the natural environment. The attributes describes in this section, however, more specifically focus on fundamental aspects of the inherent human relationship to nature. Twelve attributes are described, the last eight of which are derived from a typology of environmental values developed by the author and described elsewhere [Kellert 1996, 1997])" (Kellert, 2008, p. 13).

Fractals: they appear similar from both near and far, implying that the degree of irregularity and/or fragmentation is identical at all scales, mathematically self-similar but not exact copies, like snowflakes and or leaves of the same tree. The presence of multiple scale versions of the same unit are common interior applications.

Indigenous materials: local or native materials, defined by the USGBC as made or created within 500 miles from the site.

Integration of parts to wholes: individual distinct components together create a greater whole, e.g. small wood planks can make up a wood floor. The same unit repeated creating a greater unit, through the multiple units being together.

Landscape orientation/ landscape features that define building form: the siting of the interior for biometeorological conditions like sunlight, wind direction, water drainage, etc. for integrating the building with the environment/ landscape that embellishes or defines the building or interior design and connects the interior to the exterior, e.g. Falling Water. The depth of sunlight penetration or the use of natural ventilation design are examples of using the orientation of the building for design.

Light and space: "A fourth biophilic design element is light and space. Twelve design attributes… [with] seven focusing on qualities of light and five focusing on spatial relationships" (Kellert, 2008, p. 11).

Natural patterns and processes: "A third biophilic design element is natural patterns and processes. This element emphasizes the incorporation of properties found in nature into the built environment, rather than the representations or simulations of environmental shapes and forms. Fifteen attributes have been identified and are described…, although this complex element is likely to be altered in the future with additional understanding" (Kellert, 2008, p. 9).

Natural shapes and forms: "The second biophilic design element is natural shapes and forms. This element includes representations and simulations of the natural world often found on building facades and within interiors. Eleven attributes are associated with this design element…" (Kellert, 2008, p. 8).

Patterned wholes: variability united, variety becomes organized in a pattern, e.g. mosaic wall art. This is seen in diverse items uniting into a singular unit.

Place-based relationships: "A fifth biophilic design element is place-based relationships. This element refers to the successful marriage of culture with ecology in a geographical context. The connection of people to places reflects an inherent human need to establish territorial control, which during the long course of our species' evolution, facilitated control over resources, attaining safety, and achieving security. Locational familiarity—the yearning for home—remains a deeply held need for most people. Eleven attributes of place-based relationships are described, the last (placelessness) being the antithesis of the others rather than a stand-alone attribute" (Kellert, 2008, p. 12).

Reflected light: light reflecting off surfaces such as light colored walls, ceilings, and reflective bodies like water and shiny surfaces, may provide sparkle. This does not include diffused reflections.

Site is the geographical boundaries of the land the building is on, while anything next to the building would include the visual distance one can see from the site.

Sensory variability/ information richness: the presence or variety of levels of: visual complexity, light, sound, touch, smell, and/or other sensory environmental conditions, for a sensuous and intellectually challenging environment (must include at least three of the various senses to start to be identified as variable).

Spaciousness: openness or large open spaces are often complemented with sheltered areas surrounding it. This is seen in spaces such as airport, train stations, etc. that are impactful vertically and/or horizontally compared to the scale of a human.

APPENDIX E

BIOPHILIA DIMENSIONS, ELEMENTS, AND ATTRIBUTES

Environmental features -These features are based upon the characteristics of the natural world which can also be present in the build environment (Kellert, 2008).

1. Color- Color enhances the ability to locate dangers and resources. People are attracted to colorful features found in nature; a full spectrum can provide health benefits (Marberry & Zagon, 1995). Color can be seen according to the main color harmonies: analogous, complementary, split complement, or full-spectrum harmony. A full-spectrum color palette can use either the equal proportions of each color or the balanced mix of various proportions of tints and shades from the hues of each of the seven colors. It can include bright colors on large surfaces, a preferred color on larger surfaces and smaller proportions of the other six colors in fabric, carpeting, artwork, etc., or it could be a neutral palette with a neutral color as the backdrop with other accents.

2. Water- Water is a basic human necessity and Ulrich found in his research review that water constantly elicits a high level of liking or preference (1993). Design needs to look at water's quality, quantity, movement, and clarity (Kellert, 2008). Water's biophilic character is expressed by how it interacts with light and can be reflective and vary its hue, interacts with natural materials providing texture, adding motion, adding white sound, and supporting life. An example is an aquarium (Mador, 2008). Ulrich (1981) found that water was more effective at holding attention and interest than urban scenes and to a lesser extent vegetation views.

3. Air- Natural ventilation is preferred to stagnant air, but the use of quality, movement, flow, clarity, and sensorial stimulation (like smell and feel) are all important aspects of this attribute. The three strategies for control of indoor contaminants include source elimination, local source control, and dilution by ventilation naturally or mechanically (usually a mechanical system is used in American healthcare) (Spengler & Chen, 2000). Combining all three strategies can maximize the air quality. Separation from contaminants like smells from local food preparation and off-gassing materials, local source control can contain nearby fumes or odors, and dilution with access to outdoor air and adjustable thermostats for responding to occupant needs are all examples of air quality control.

4. Sunlight or daylight- Natural light and has been seen to improve morale, health, and productivity over the use of artificial light (See the light attributes).

5. Plants- Offering food, fodder, and providing security, plants can enhance physical satisfaction, well-being, and performance (Kellert, 2008). One research example found the presence of indoor plants in a hospital room reduced perceived stress in patients (Dijkstra, Pieterse, & Pruyn, 2008).

6. Animals- Animals are sources of food, and offer other resources and protection. While providing companionship, they may also incite fear. Animal presence in pictures has exhibited positive influence on social attribution and pets have been found to positively affect human health and longevity (Beck & Katcher, 1996).

7. Natural materials- From plants, animals, or the ground, natural materials are generally preferred over the artificial/man-made and can be partly explained by the artificial material's inability to reveal the natural process of aging or the natural exchange of energy through natural systems. Natural materials are often information-rich and stimulate imaginary play (J. Heerwagen & Orians, 2002).

8. Views and vistas-People prefer exterior views of natural features like savannas, water, or vegetation (Ulrich, 1981, 1993) . The most satisfying views are scaled and proportioned according to the landscaping and the built environment. The healing influence from nature views was first found by Ulrich (1984) and showed within less than five minutes viewing nature settings can produce positive restoration after stress (Ulrich, 1981).

9. Façade greening- Exterior plant coverage, ex. ivy walls often reflect cultural and historical associations (for the interior this included under plants).

10. Geology and landscape- This shows the connection of the building to geology (interior relevance included in geomorphy).

11. Habitats and ecosystems- Buildings mimicking local habitats connect the space to the locality (interior relevance included in geomorphy).

12. Fire- Fire is often preferred in the interior but is a safety challenge, especially in a hospital environment. It is seen as providing comfort and civilization when controlled and adds color, warmth, and movement. The warmth and possible destructiveness of fire are alluring (Fisher, Salmela, & Bastianelli Kerze, 2005)

Natural shapes and forms -These shapes and forms are representations and simulations of the natural world.

13. Botanical motifs- Natural occurring shapes, forms, and patterns of plants and vegetative matter include examples like framed leaves (a natural example) and artistic trompe d'oeil painting of plants (representation). The draw to greenery and plants is seen in research showing health-related benefits by simply looking at gardens and plants or experiencing surroundings where plants are prominent in healthcare environments (Ulrich, 2002).

14. Tree and columnar supports- Natural occurring shape that represents tree like shapes most often as columnar supports and in multiples (Kellert, 2008). Actual large timber construction can be a natural example.

15. Animal (vertebrate) – The simulation of animal life includes their individual components. (Form emphasis covered under Animals)

16. Shells and spirals (invertebrates) – Natural occurring invertebrate shapes are the most common in in shell and spiral forms. The escallop and nautilus have been in use since Graeco-Roman times and were very popular in Rococo. Among the Eight Buddhist Emblems of Happy Augury was the conch shell. These shell motifs are often used as a heraldic symbol (Stafford & Ware, 1974)

17. Egg, oval, and tubular forms- Natural occurring ovular shapes are often used as ornament and are another examples of unique nature derived forms humans have been drawn to incorporate, seen in the egg-and-dart, that the Greeks called ovolo in ancient Greek architecture (Stafford & Ware, 1974).

18. Arches, vaults, domes-Natural occurring curve shapes copy forms in nature for decorative or functional purposes and also have a long history of architectural use (Lewis & Darley, 1986).

19. Shapes resisting straight lines- In nature features rarely are revealed as straight lines or right angles and are often used as defining the natural vs. manmade.

20. Simulation of natural features- The simulation of nature reaffirms a tendency to simulate rather than replicate actual natural forms. This includes creative interpretation of forms only vaguely reminiscent of the original natural inspiration (covered specifically in the other Natural shapes and forms elements).

21. Biomorphy- Bearing very little resemblance to living forms, biomorphy simulates rather than replicates natural forms, such as the Sydney Opera House looks inherently natural with no specific natural reference.

22. Geomorphy- Geomorphy replicates or mimics nearby geology, stratified surfaces, rooted relationships to other components, or landscaping relatively adjacent to the space showing an earth inspiration.

23. Biomimicry- Mimicking or imitation of nature's model, biomimicry can include animals, plants, or other natural systems but may focus on function over duplication of form. It is nature as a model, a measure, and a mentor (Benyus, 2002).

Natural patterns and processes- *These* patterns and processes are properties found in nature.

24. Sensory variability- Human satisfaction and well-being within an environment is reliant upon both perceiving and responding to sensory variability. It is the collective effects of visual, auditory, olfactory, and tactile stimulation. Note East/West window configurations for seasonal variations of light. Variety of smells and colors are additional examples. All of the senses should be stimulated.

25. Information richness- Information can stimulate curiosity, imagination, exploration, discovery, and problem-solving. Information richness is seen in variety, texture, and details that mimic natural patterns.

26. Age, change, and the patina of time- Showing aging through time is part of natural materials and processes.

27. Growth and efflorescence- This is seen in the effects of buildings encountering moisture (Exterior focus).

28. Central focal point- The use of a reference point transforms chaotic into organized.

29. Patterned wholes- Variability is unified with patterned wholes and can add structure to disorganization (see parts to wholes).

30. Bounded spaces- A delineated space has clear boundaries. Proportion and scale can be varied to accomplish this. Clearly demarcated space can provide a sense of refuge.

31. Transitional spaces- The access between spaces can include areas in between other areas or among various rooms that provide a distinct difference of design between the spaces they connect. The space should provide prospect to the other space(s), while enticing one to continue. The author lists doors and thresholds, but this was not included in the matrix as every environment has door or threshold, but the use of a transitional space between rooms, like halls was measured.

32. Linked series and chains of spaces- Connected spaces bring you from one room or space to another as seen in enticement.

33. Integrations of parts to wholes- Discrete parts comprise a whole such as an entire open floor plan divided into separate functions and a gable end being divided into repetitive units (Fisher et al., 2005).

34. Complementary contrasts- Adding meaning and intelligibility as well as interest and stimulation can be obtained through the blending of contrasting features, for example: light and dark, open and closed, warm and cool colors, warm and cool temperatures, smooth and rough textures. Opposites are often found together in nature.

35. Dynamic balance and tension- Showing strength and durability from balancing contrasting forms add creative tension which changes the static to appear organic.

36. Fractals- The fractal as a non-Euclidian shape was mathematically explained by Benoit Mandelbrot who said they "tend to be scaling, implying that the degree of their irregularity and/or fragmentation is identical at all scales (Mandelbrot, 1982, p. 1). The aesthetic benefit fractals have on human psychology and physiology is through its inherent nature based shape and its organized complexity. Humans connect with these shapes physiologically and psychologically (Kellert, 2008).

37. Hierarchically organized ratios and scales- Arithmetic and geometry create highly complex patterns without seeming overwhelming and can occur in hierarchically connected ways. Fibonacci's sequence is an example that can be found in the order of some stems on plants, golden spirals in a Nautilus shell, the number of petals on some flowers, the golden section of animals proportions like dolphins, and the golden ratio seen in the proportion of the human hand to the forearm (0,1,1,2,3,5,8,13,21,34,55,89,144,…).

Light and space- These attributes look at the qualities of light and spatial relationships.

38. Natural light- Sunlight, with full color spectrum, shows evidence of changing through time as part of the natural diurnal and yearly cycles. First graders in a classroom setting were studied with standard artificial lighting compared to full-spectrum. This research showed dramatic improvement in the behavior of hyperactive children and the class settled down more quickly, paid more attention to teachers, and was less nervous with better overall performance compared to the control group not using full spectrum lighting (Ott, 1976). Another study with classrooms varied the access to daylight with two types of fluorescent lighting and showed that the classroom without both daylight and full spectrum fluorescent lighting demonstrated the greatest disturbance in the chrono-biological systems that regulate hormones. Additionally, exposure to the seasonal patterns of daylight influenced hormone levels and positively impacted the student's ability to concentrate, co-operate, and resist sicknesses (Küller & Lindsten, 1992). Daylight entering from different heights has the most dramatic experience of light movement. In a study of seasonal affective patients who stayed in sunny rooms in the hospital, they spent fewer days in the hospital than those in dimly lit rooms (Beauchemin & Hays, 1996).

39. Filtered and diffused light- Modulated daylight can add connection to other spaces and reduce glare. Daylight should come from at least two directions to offer diffused light from one direction at all times and be modulated by filters if necessary.

40. Light and shadow-Light and dark is usually present together in nature and when used together can increase human curiosity, mystery, and stimulation. Daylight from at least two directions can show the movement of the sun and the changing patterns of brightness and shadow.

41. Reflected light- Reflected light adds sparkle to a space. Lighting designs use light colored walls, ceilings, and reflective surfaces to increase reflectivity, as well as use accent lights. Functional benefits from proper amounts of reflected light include not only the mitigation of glare, but also an increased penetration of light (ex. a light shelf). Reflections can also act as secondary light sources.

42. Light pools- Pools of connected light can draw someone through a space and aid in way finding. Light pools can add a sense of security when contrasting a darkened area, such as a lighted hearth or accent lighting.

43. Warm light- Warmly lit spaces are often areas of filtered daylight surrounded by darkened spaces. They can feel like an island and enhances the feeling of nesting and security.

44. Light as shape and form- Manipulated light can create an aesthetic form. Pleasing sculptural light forms may facilitate exploration, discover, and mobility.

45. Spaciousness- Open areas proximal to sheltered areas or larger areas next to smaller areas add to spatial variety.

46. Spatial variability- Differentiation of light, mass, and/or scale can foster emotional and intellectual stimulation. Spaciousness as seen in prospect should be accompanied by smaller, refuge-rich spaces creating variety. Examples include changes in ceiling heights with relation to room expanse. This is complimented with spatial harmony.

47. Space as shape and form- Manipulating space through form stimulates interest and exploration.

48. Spatial harmony- Space(s) showing a blending of light, mass, and/or scale within a defined space will evoke a sense of harmony and lead to feelings of security, and safe movement through the space(s).

49. Inside-outside spaces- Connecting the interior to the exterior for indirect nature connection is found in colonnades, porches, foyers, and interior gardens.

Place-based relationships   Culture with ecology in a geographic setting

50. Geographic connection to place- Connecting the space to the geography of the area offers feelings of familiarity (using geomorphy and ecological connection to place for measurement).

51. Historic connection to place- Representing the past may mark the passage of time and adds a sense of culture and collective awareness.

52. Ecological connection to place- Representing local, dominate ecological and bio-geographical features adds to the sense of place.

53. Cultural connection to place- Culture is a universal human need and distinctive vernacular architectural forms adds to that connection.

54. Indigenous materials- Local materials provide a connection to local culture and offer a more sustainable option. The LEED rating system uses a radius of 500 miles to determine if it is a local material (USGBC, 2009). A visual inventory may require prior/post research.

55. Landscape orientation- The orientation of features of the landscape connect the landscape to the building (not included due to exterior focus)

56. Landscape features that define building form- These features define and integrate the building to the landscape (not included due to exterior focus)

57. Landscape ecology- Long term landscape design looks to local biophysical contextual needs for decisions: connections, corridors, and biodiversity (not included due to exterior focus).

58. Integration of culture and ecology- Long term sustainability and stewardship come from nature and humanity interacting with awareness of each other's needs (not included due to exterior focus).

59. Spirit of place- Spirit of place is found in the cherishing of components found in the individual and collective identity within a place (needs human measurements, but can result from other Place-Based elements)

60. Avoiding placelessness- Avoiding the corrosive separation of the built environment from its bio-cultural context is needed to keep a place based relationship (needs human measurements, not included).

Human-nature relationships- These include fundamental aspects of the human-nature relationship.

61. Prospect and refuge- The collective effects of prospect and refuge should provide protection while also offering permeable boundaries for providing the prospect view of the surrounding area (Kahn & Kellert, 2002). The use of these elements in a play space can be seen in children's affinity for climbing into small spaces (refuge) and surveying through climbing up on top of objects (prospect). The use of small semi-enclosed spaces can support onlooker or solitary play, or can be used to support play with a few others in associative or cooperative play. Entrances should allow for children to survey the space before entering. Also, the access to safely achieved heights can supply a form of survey, examples can be found in elevated forts, slides, or climbing walls. Semi enclosed spaces for refuge can also be found in forts.

62. Order and complexity- Balancing order with intricacy can be found in the systematic repetition of visually complex design elements. Too much complexity/intricacy results in chaos and order alone is monotony, so complexity needs to be paired with order just as complexly ordered sound is called music, but chaotically complex sound

is called noise. Similarly, we distinguish buildings by the evident order and complexity of the materials used.

63. Curiosity and enticement- Curiosity is the need for exploration and creativity. Enticement draws our interest. Paired together they can exercise imagination and creativity through using layers of details to draw out interest. The movement from darkness to brightness within a building is enticing. Variety can also draw out enticement (seen in the various elements listed above).

64. Change and metamorphosis- Present in growth, maturation, and metamorphosis, this combined quality can be seen in the flow from one form or state to another.

65. Security and protection- Security from threatening forces does not include isolation from the world (difficult to measure level of security and protection from photographic study).

66. Mastery and control- Dominance over nature can foster human ingenuity and self-confidence (seen in the safe zone designation of a play space).

67. Affection and attachment- Eliciting strong emotion for nature often increases loyalty and appreciation for the building (needs human measurements).

68. Attraction and beauty- Forming an aesthetic appreciation for natural process and form (needs human measurements).

69. Exploration and discovery- Information-rich and intellectually rich buildings offer opportunities for exploration and discovery of natural processes (needs human measurements).

70. Information and cognition- This is fostered through complexity of natural shapes and forms. Direct and indirect use of nature and the use of ornamentation can foster critical thinking and problem solving (needs human measurements).

71. Fear and awe- The possible peril of the unknown reinforces the need for safety found in the need for prospect and refuge. The built environment normally can offer perils that can be controlled, however the hospital offers a lack of control and varieties of unique situations that may bring on fear. The play spaces are a space removed from medical attention and intervention, or a safe zone, so a lack of fear is desired (not included for applicability, however some mild fear based play may be appropriate).

72. Reverence and spirituality- Affirming the need for meaningful relations to creation and connections that defy the aloneness of a single person, reverential connection to nature can be supported through spirituality (needs human measurements, not included).

APPENDIX F
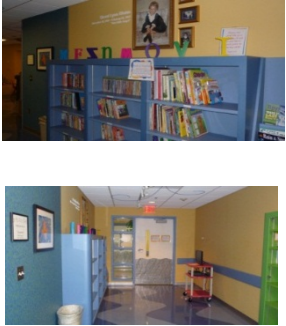
BIOPHILIC INTERIOR DESIGN MATRIX SAMPLE
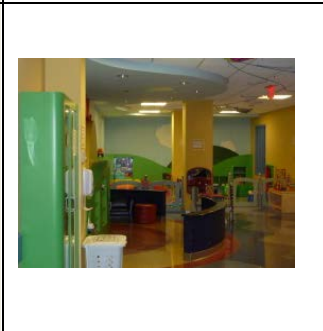
	Biophilic Element	Scale: Place an X if present	Description Element(s) in room	Photo Example
Environmental features				
1	**Color:** any type of color	x	multiple colors dominated with red, yellow, green, and blue	
2	**Water:** any type of water	x	utility sink provides water access	
3	**Air:** natural ventilation			
4	**Plants:** actual plants in any form (alive or once alive)			
5	**Animals:** actual animals in any form (alive or once alive)			
6	**Natural materials:** not artificially made and coming from the environment, e.g. wood, stone, metal, and paper	x	wood furniture and wall toys	

7	**Views and vistas:** exterior views of natural features such as vegetation		
8	**Fire:** providing comfort and civilization when controlled with color, warmth, and movement		
Natural shapes and forms			
9	**Botanical motifs:** representations found in shapes, forms, and patterns of plants and vegetative matter	x	green pasture shelving unit	
10	**Tree and columnar supports:** appearance or simulation of treelike shapes, especially rounded/columnar supports	x	tree column	
11	**Animal:** representations of animals, e.g. animal forms, claws, and heads which may be highly stylized	x	animal features like animal shaped chairs, turtle play pin	
12	**Shells and spirals:** invertebrate representations with the most common being shell and spiral forms, bees and their hives, flies, butterflies, insects, spiders and their webs.	x	spiral ceiling detail	

13 **Egg, oval, and tubular forms:** often used as design element details and seen in ornament and structural purposes such as columns, molding, and fountains	x	tubular chair supports	
14 **Arches, vaults, domes:** copying these forms found in nature for decorative or functional purposes, including beehives, nests, shell forms, and cliffs often found in decorative and functional purposes	x	arched gates, arch work table	
15 **Shapes resisting straight lines:** often sinuous, flowing and adaptive to forces found in nature, nature features rarely are revealed as straight lines or right angles	x	multiple undulating lines present	
16 **Simulation of natural features/ biomorphy:** a simulation rather than replication of natural form; ornamentation or decoration of imagined forms are vaguely reminiscent of those naturally found (shape of the Sydney Opera house)	x	water like flooring	
17 **Geomorphology:** replicating or embracing nearby geology or landscaping next to the building into the interior			

18 **Biomimicry:** a viewing of nature as a model; the imitation of functions found in nature can include the shapes of both animals and plants but focuses on function over replication of form.			
Natural patterns and processes			
19 **Sensory variability/ information richness:** the presence or variety of levels of: visual complexity, light, sound, touch, smell, and/or other sensory environmental conditions, for a sensuous and intellectually challenging environment	x	variety of sound (TV), lighting, textures, color	
20 **Age, change, and the patina of time:** showing aging such as wear or growth particularly by organic forms like wood but even inorganics like stone			
21 **Central focal point:** a singular point of reference or interest in a space	x	central them of pastureland focused in a defined activity area	
22 **Patterned wholes:** variability united, variety becomes organized in a pattern, e.g. mosaic wall art	x	mosaic tile and flooring	
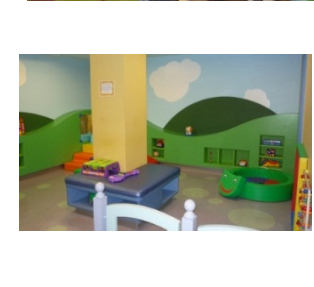
23 **Bounded spaces:** as in a delineated space with clear boundaries, defined territories, and place demarcations	x	separated screen area across from sink and storage area	
24 **Transitional spaces:** a space providing access between spaces, including hallways, bridges, etc.	x	dedicated entry area	
25 **Linked series and chains:** connected spaces bring you from one space to another in a series	x	entry area connects to main play space and to sink and projector area	
26 **Integration of parts to wholes**: individual distinct components together create a greater whole, e.g. small wood planks can make up a wood floor	x	Larger theme represented throughout the furniture and built-ins with use of same materials and finishes	

27	**Complementary contrasts:** blending of contrasting features or opposites, like light and dark, open and closed, high and low	x	open and closed storage	
28	**Dynamic balance and tension:** different or contrasting shapes, forms, and materials may foster a sense of strength and durability, this blending of varying forces often produces a quality of creative tension that makes static forms appear organic	x	large rectilinear columns differ from the curvilinear lines of the space and add a sense of strength	
29	**Fractals:** they appear similar from both near and far, implying that the degree of irregularity and/or fragmentation is identical at all scales, mathematically self-similar but not exact copies, like snowflakes and or leaves of the same tree			
30	**Hierarchically organized ratios and scales:** arithmetically or geometrically based, this can be seen in naturally occurring patterns, e.g. golden ratio, golden sections, golden proportion, golden spiral, and Fibonacci's sequence (0,1,1,2,3,5,8,13,21,34 ...) such as the head of a sunflower and the petals of an artichoke, these can be highly… complex patterns yet seem organized			

Light and space			
31 **Natural light:** daylight/sunlight access			
32 **Filtered and diffused light:** modulated daylight, to reduce glare, e.g. blinds and shades	x	filtered light comes in through red window from teen play area	
33 **Light and shadow:** light and dark or shadowed spaces			
34 **Reflected light:** light reflecting off surfaces such as light colored walls, ceilings, and reflective bodies like water and shiny surfaces, may provide sparkle	x	reflective metallic flecks in red glass and flecks in blue paint on partial wall around media play area	
35 **Light pools:** pools of connected light in a series (may include shadow) on the floor or wall drawing you from one area to another			
36 **Warm light:** warmly lit areas feel secure and inviting; the warm glow, sunlight, or fire is often surrounded by areas of darker spaces			

37	**Light as shape and form:** manipulated natural light to create aesthetic forms, e.g. light shaft		
38	**Spaciousness:** openness or large open space is often complemented with sheltered areas surrounding it		
39	**Spatial variability:** changes of light, mass and scale such as ceiling heights, room widths, etc. for visual variety in the definition of the space (hopefully balanced with unity to create spatial harmony, see #41)	x	variety of room shapes with various defined spaces and accent lighting emphasizes design and furniture
40	**Space as shape and form:** space that is manipulated into form or shape	x	center media area defined into a semi-sphere
41	**Spatial harmony:** harmony in a space is often seen in a unifying commonality among the varied light, mass, and scale within a well defined boundary	x	variety in lighting, spatial definition with room massing add harmony to through unifying theme and ceiling height
42	**Inside-outside spaces:** interior spaces that appear connected to the outside environment, like porches foyers, and interior gardens		

Place-based relationships			
43 **Geographic connection to place:** connecting the space to the geography of the site offers familiarity, e.g. use of local features, siting of the room, selection of views, etc.			
44 **Historic connection to place:** relation to past through the marking of the passage of time, linking the past to present, fostering a cultures collective memory, e.g. historical images	x	Historic reminder of previous patient from benefactor	
45 **Ecological connection to place:** connection to local, dominate ecological and/or biogeographical features of the region, e.g. mountains, deserts, rivers, oceans	x	Rolling pasture-like landscape	
46 **Cultural connection to place:** integrated history, geography, and ecology of an area, e.g. architectural heritage of a people, particularly its treasured and distinctive vernacular (local) forms			
47 **Indigenous materials:** local or native materials			

48 **Landscape orientation/ landscape features that define building form:** the siting of the interior for biometeorological conditions like sunlight, wind direction, water drainage, etc. for integrating the building with the environment/ landscape that embellishes or defines the building or interior design and connects the interior to the exterior, e.g. Falling Water			
Human-nature relationships			
49 **Prospect AND refuge:** a place with the ability to survey the distance/ a view of the entire space and a place of protection/ separated from spaciousness	x	climbing zone for toddlers, small house are a few of the prospect and refuge additions, entry area	
50 **Order AND complexity:** a balance of structured organization with intricacy of detail that together appears orderly, designs that meld order with complexity stimulate the desire for variety in a controlled manner	x	built in storage balances visual complexity with order through location, size, and color	

51	**Curiosity AND enticement:** spaces that elicit exploration, discovery, creativity, or mystery	x	a variety of activities at different heights with different tactile and visual information brings curiosity and enticement	
52	**Change and metamorphosis:** present in growth, maturation, and metamorphosis and seen when one form or state changes to another			

Total score   **30**

MATRIX ANALYSIS TABLE

The table below contains the finalized scoring for all of the facilities, including averages. The table is divided into the six biophilic design elements with the related design attributes under the appropriate elements. The attributes and elements are listed along the rows and the facilities along the columns.

Biophilic Design Matrix Table		Facility Play Room												
Attributes	1	2	3	4	5	6	7	8	9	10	11	12	13
Environmental Features														
1 **Color**	x	x	x	x	x	x	x	x	x	x	x	x	x
2 **Water**	x		x			x	x		x	x	x	x	x
3 **Air**						x		x					
* **Sunlight-s**ee 31	*	*	*	*	*	*	*	*	*	*	*	*	*
4 **Plants**													
5 **Animals**						x							
6 **Natural materials**	x	x	x	x	x	x	x	x	x	x	x	x	x
7 **Views & vistas**	x				x	x		x	x				
8 **Fire**													
subscore	4	2	3	2	3	6	3	4	4	3	3	3	3
Natural Shapes and Forms														
9 **Botanical motifs**	x		x			x	x	x			x	x	
10 **Tree & columnar supports**	x					x	x					x	
11 **Animal**	x	x	x			x	x		x	x	x	x	x
12 **Shells & spirals (invertebrates)**	x					x	x	x	x	x		x	x
13 **Egg, oval, and tubular forms**	x	x	x	x	x	x	x	x	x	x	x	x	x
14 **Arches, vaults, domes**	x	x				x	x			x		x	x
15 **Shapes resisting straight lines**	x		x	x	x	x	x	x	x	x	x		x
16 **Simulation of natural features/ biomorphy**	x			x		x	x		x			x	x
17 **Geomorphology**						x						x	
18 **Biomimicry**	x												
subscore	9	3	4	3	2	9	8	4	5	5	4	8	6

Biophilic Design Matrix Table	Facility Play Room												
Attributes	1	2	3	4	5	6	7	8	9	10	11	12	13
Natural Patterns and Processes													
19 **Sensory variability/ Information richness**	x	x	x		x	x	x	x		x	x	x	x
20 **Age, change, the patina of time**		x		x							x		
21 **Central focal point**	x				x	x	x	x	x				x
22 **Patterned wholes**			x	x	x	x	x		x		x		
23 **Bounded spaces**	x	x	x	x	x	x	x	x	x	x	x	x	x
24 **Transitional spaces**	x				x	x	x						
25 **Linked series and chains**	x	x	x	x	x	x	x	x		x		x	
26 **Integrations of parts to wholes**	x	x	x	x	x	x	x	x	x	x			
27 **Complementary contrasts**	x			x	x	x	x	x	x	x	x	x	x
28 **Dynamic balance and tension**	x		x	x	x	x	x			x		x	x
29 **Fractals**	x												
30 **Hierarchically organized ratios & scales**													
subscore	9	5	6	7	9	9	9	6	5	6	5	5	5
Light and Space													
31 **Natural light**	x	x	x	x	x	x		x	x				
32 **Filtered and diffused light**	x	x	x	x	x	x	x	x	x				
33 **Light and shadow**	x	x		x		x		x			x		

Biophilic Design Matrix Table	Facility Play Room												
Attributes	1	2	3	4	5	6	7	8	9	10	11	12	13
Light and Space Continued													
34 **Reflected light**		x				x	x	x					x
35 **Light pools**						x							
36 **Warm light**													
37 **Light as shape and form**	x	x	x	x									
38 **Spaciousness**	x					x							
39 **Spatial variability**	x		x	x		x	x	x		x			
40 **Space as shape and form**				x			x						
41 **Spatial harmony**	x			x		x	x			x			x
42 **Inside-outside spaces**						x		x					
subscore	7	5	4	7	2	9	5	6	2	2	1	0	2
Place-Based Relationships													
43 **Geographic connection to place**	x	x				x							
44 **Historic connection to place**	x		x				x						
45 **Ecological connection to place**	x		x			x	x				x		
46 **Cultural connection to place**	x												
47 **Indigenous materials**													
48 **Landscape orientation/ landscape features …**	x					x							
subscore	5	1	2	0	0	3	2	0	0	0	1	0	0

Biophilic Design Matrix Table	Facility Play Room												
Attributes	1	2	3	4	5	6	7	8	9	10	11	12	13
Human-Nature Relationships													
49 **Prospect AND refuge**	x			x		x	x			x		x	
50 **Order AND complexity**	x	x		x		x	x			x	x	x	x
51 **Curiosity AND enticement**	x	x	x	x		x	x	x		x		x	x
52 **Change AND metamorphosis**													
subscore	3	2	1	3	0	3	3	1	0	3	1	3	2
Total score	37	18	20	22	16	39	30	21	16	19	15	19	18

Biophilic Design Matrix Table	Facility Play Room											
Attributes	14	15	16	17	18	19	20	21	22	23	24	Total
Environmental Features												
1 **Color**	x	x	x	x	x	x	x	x	x	x	x	24
2 **Water**		x	x	x	x	x	x	x	x		x	18
3 **Air**												2
* **Sunlight** (see #31)	*	*	*	*	*	*	*	*	*	*	*	*
4 **Plants**												0
5 **Animals**												1
6 **Natural materials**	x		x	x	x	x	x	x	x	x		22
7 **Views and vistas**		x	x		x	x	x	x	x			12
8 **Fire**												0
subscore	2	3	4	3	4	4	4	4	4	2	2	3.29167
Natural Shapes and Forms												
9 **Botanical motifs**			x	x			x	x		x	x	13
10 **Tree and columnar supports**												4
11 **Animal**			x	x	x	x	x	x				16
12 **Shells and spirals (invertebrates)**		x	x	x	x	x	x	x	x			16
13 **Egg, oval, and tubular forms**	x	x	x		x	x	x	x	x	x	x	23
14 **Arches, vaults, domes**				x	x	x	x	x			x	13
15 **Shapes resisting straight lines**		x	x		x	x	x	x	x	x	x	20
16 **Simulation of natural features/ biomorphy**	x	x	x	x	x	x	x	x			x	16
17 **Geomorphology**												2
18 **Biomimicry**												1
subscore	2	4	6	5	6	6	7	7	3	3	5	5.16667

Biophilic Design Matrix Table	Facility Play Room											
Attributes	14	15	16	17	18	19	20	21	22	23	24	Total
Natural Patterns and Processes												
19 **Sensory variability/ Information richness**	x	x			x	x	x	x	x	x	x	20
20 **Age, change, and the patina of time**			x									4
21 **Central focal point**	x		x	x								10
22 **Patterned wholes**	x	x		x	x	x	x	x	x	x	x	17
23 **Bounded spaces**	x	x	x	x	x	x	x	x	x	x	x	24
24 **Transitional spaces**					x	x						6
25 **Linked series and chains**	x	x		x	x	x	x	x		x		18
26 **Integrations of parts to wholes**	x		x		x	x	x	x		x	x	17
27 **Complementary contrasts**		x	x	x	x	x	x	x	x	x	x	21
28 **Dynamic balance and tension**	x	x			x	x	x	x		x	x	17
29 **Fractals**	x											2
30 **Hierarchically organized ratios and scales**												0
subscore	8	6	5	5	8	8	7	7	4	7	6	6.54167
Light and Space												
31 **Natural light**	x	x	x		x	x	x	x	x	x		17
32 **Filtered and diffused light**	x	x	x		x	x	x	x	x	x		18
33 **Light and shadow**												6

Biophilic Design Matrix Table	Facility Play Room											
Attributes	14	15	16	17	18	19	20	21	22	23	24	Total
Light and Space Continued												
34 **Reflected light**	x											6
35 **Light pools**		x										2
36 **Warm light**												0
37 **Light as shape and form**					x	x	x	x				8
38 **Spaciousness**												2
39 **Spatial variability**	x	x			x	x	x	x	x	x	x	16
40 **Space as shape and form**												2
41 **Spatial harmony**	x	x			x	x	x	x		x		13
42 **Inside-outside spaces**												2
subscore	5	5	2	0	5	5	5	5	3	4	1	3.83333
Place-Based Relationships												
43 **Geographic connection to place**											x	4
44 **Historic connection to place**	x	x										5
45 **Ecological connection to place**		x	x	x								8
46 **Cultural connection to place**												1
47 **Indigenous materials**			x									1
48 **Landscape orientation/…**					x	x	x	x	x			7
subscore	1	2	2	1	1	1	1	1	1	0	1	51

Biophilic Design Matrix Table	Facility Play Room											
Attributes	14	15	16	17	18	19	20	21	22	23	24	Total
Human-Nature Relationships												
49 **Prospect AND**	x						x			x	x	10
50 **Order AND complexity**	x	x			x	x	x	x		x	x	17
51 **Curiosity AND enticement**										x	x	12
52 **Change AND meta-morphosis**												0
subscore	2	1	0	0	1	1	2	1	0	3	3	1.625
	20	21	19	14	25	25	26	25	15	19	18	**21.54**