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The Intangible Aspects of Architectural Spaces that Influence Human Well-being

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RÉSUMÉ

En utilisant des approches qualitative and quantitative cette thèse démontre que les aspects intangibles des espaces architecturaux influencent le bien-être humain. Le but est de faire savoir que les espaces intérieurs ont un impact sur le bien-être et que l'architecture peut être considérée comme une solution pour satisfaire les besoins des usagers.

Dans la première étude, l'approche qualitative est explorée en utilisant la narration pour identifier les aspects intangibles des espaces intérieurs qui affectent le bien-être. Une discussion s'articule autour du Modèle de Réponses Expérientielles des Humains (Model of Human Experiential Responses to Space) et de son importance comme outil pour déterrer les caractéristiques environnementales qui influencent le bien-être et qui peut être utile pour les professionnels du design. Les résultats démontrent que 43 catégories sont interprétées comme étant des aspects intangibles et servent de canevas pour trois autres études. Les résultats démontrent que certaines caractéristiques environnementales similaires dans les résidences et les bureaux augmentent le sentiment de satisfaction et de bien-être.

Dans la deuxième étude, une approche quantitative est explorée en utilisant les neurosciences et l'architecture afin de mesurer comment les espaces architecturaux affectent le bien-être. Le concept de neuroscience / environnement / comportement est utilisé où huit corrélats neuroscientifiques (Zeisel 2006) sont investigués afin de mesurer les effets du cerveau sur les espaces architecturaux. Les résultats démontrent que l'environnement peut affecter l'humeur, le niveau d'attention et le niveau de stress chez les humains et peut également augmenter leur performance.

Les deux études contribuent aux connaissances que les caractéristiques environnementales affectent l'humeur et le niveau de satisfaction de la même façon dans les espaces résidentiels et dans les espaces de bureaux. Un bon environnement qui énergise les employés peut affecter leur performance au travail de façon positive (Vischer 2005).

MOTS-CLÉS: Espaces architecturaux, Aspects intangibles, Bien-être, Corrélats neuroscientifiques, Psychologie de l'environnement.

ABSTRACT

This research uses qualitative and quantitative approaches in order to demonstrate how intangible aspects of architectural spaces influence human well-being. The goal is to increase awareness that interior spaces do impact human well-being and that architecture can be regarded as a solution to satisfy space users' needs.

In the first study a qualitative approach is explored through narrative inquiry in order to identify intangible aspects of residential and office spaces that affect human well-being. A discussion is built around the Model of Human Experiential Responses to Space and its purpose as a tool to unearth environmental characteristics that enhance well-being and can be of value to design professionals. Results show that 43 categories are interpreted as being intangible aspects of architectural spaces that influence human well-being. These categories are then used for three other studies to find out if there are any underlying regularities in environmental characteristics that affect user moods and feelings. Results show that similar environmental characteristics heighten sense of satisfaction and well-being for both residential and office space users.

In the second study, a quantitative approach is applied to neurosciences and architecture in order to measure how architectural spaces influence human well-being. Neuroscience and environment / behaviour concepts are used where eight brain-based neuroscientific correlates (Zeisel 2006) are investigated in order to measure brain effects on architectural spaces. Neuroscientific outcomes reveal that the environment can affect human moods, ability to focus attention and stress levels and may also heighten task performance.

Both studies contribute to knowing how space users feel environmental characteristics affect their mood and satisfaction. They reveal that people's moods may be affected similarly in residential or office space settings and that a good environment that energizes employees will affect their work performance in a positive way (Vischer 2005).

KEY WORDS: Architectural Spaces, Intangible Aspects, Human Well-Being, Neuroscientific Correlates, Environmental Psychology.

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I dedicate this thesis to professionals who seek to design architectural spaces for the well-being of space users. May the results found in this research be useful to designing healthy spaces to live in and serve as an essential guide to space users.

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I would also like to thank two organizations; the Cirque du Soleil and the Society of Neurosciences for enabling me to visit their offices and interview their employees so that they could narrate their stories as to how environmental characteristics of architectural interiors influence well-being for space users in office-space settings.

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INTRODUCTION

With my involvement in the architectural and interior design fields for several years it struck me that the designing of spaces had often revolved around functional, aesthetic or budgetary considerations as well as the expediency with which projects had to be delivered. It often seemed that as long as the final outcome appeared to be to the taste of the day and that someone was making money, the resulting project was considered a success.

I also noticed that during some of the yearly commercial design contests, the first, second and third prizes often featured projects that all resembled each other with shapes, materials and hues of colors that were in vogue. Of course creativity can be similar from one project to another and from one design firm to the next. After hearing clients articulate thoughts such as '*our designer suggested these colours but we don't really like them*', or '*the architect who did this may be famous and his architecture may be poetic, but this space is absolutely not functional for us*', or '*I know these are the trends, but we are not really into this'*,… it made me wonder what the purpose of design was, if it wasn't to suit the needs of space users.

Along with cost considerations, code regulations and aesthetic qualities a good design can be achieved when it responds to the satisfaction and long-term well-being of its occupants. This may be easy to say for small residential settings where designers are in close contact with the client who is most often the space user. It may not be as easy to do in the case of corporate projects as the client and employees that are interviewed during the design process may not necessarily be the ones that will be occupying the space after it is built.

Knowing that performing research to access opinions on how humans feel environmental characteristics influence them was essential, I began to wonder about what characteristics of architectural spaces could give space users a chance to reach their full potential. Not able to identify one, two or even three aspects in particular, it became clear that a whole series of characteristics comprised architectural spaces. These characteristics

put together create an overall atmosphere that is intangible and that can influence space users' mood, satisfaction and well-being.

In scientific fields, where research is a way to discovering new issues and advancing professions, practice also advances while benefiting from these findings. Therefore, when making a place for research in practice-based fields such as those related to environmental planning (ex: architecture, interior design, industrial design, …) designers can use results to base their design decisions in order to answer to space users needs, satisfaction and long-term well-being. Enhancing dialogue between space users and designers and considering the voices of persons who are sensitive to space may not only meet their needs but also those of others. Since environments play a major role in shaping the human brain and impacting human development and well-being, it is of utmost importance that professionals design spaces that correspond to the long-term well-being of space users. It is therefore essential that designers work hand in hand with research teams in order to access data derived from space users and that tools be developed to facilitate this process.

This study therefore explores the intangible aspects of architectural spaces through narrative inquiry as well as neuroscientific measurement in order to access human experiential material so as to better understand and respond to space users' needs. First, a subjective approach using narrative inquiry is explored to find initial characteristics of architectural spaces that influence human well-being. Then a quantitative approach using neuroscientific correlates is explored. The research methods complement each other in finding out what it is about the environment that enhances human well-being. The goal is to combine research and practice in order to better understand what makes space users feel 'right' so that design professionals can design spaces while considering the long-term well-being of space users.

CHAPTER 1:

INTANGIBLE ASPECTS OF ARCHITECTURAL SPACES

Challenges of the unknown motivate researchers who want to create more humane environments and to improve the way humans interact with space. To better understand what constitutes these environments, intangible aspects of architectural spaces[1] is the subject of this study, along with how they may affect human moods, comfort and satisfaction. These aspects will be examined through the framework of environmental psychology where research findings can be useful for design professionals who aim at designing spaces for user well-being. This chapter unveils what is known about the Interior Design Body of Knowledge (Guérin and Martin 2004) and how intangible aspects of architectural spaces that enhance human well-being can contribute to filling the gap within this body of knowledge. This will be correlated to human behaviour / built environment relationships, as well as to the influence of architectural spaces on human well-being.

Chapter two explores the research context and methodological approaches in this study that are aimed at finding out what intangible aspects of architectural spaces enhance human well-being. Both qualitative and quantitative approaches are investigated. Narrative inquiry is used to capture subjective human responses to space and neuroscientific research uses scientific methods to impact the experience-based intuitions of professional designers.

Chapter three gives a step-by-step outline of the study, where the concept of *intangibles* is made more explicit and how it is related to the concept of *sense of place*. Explanations are given as to why this research has been presented in article format in order to contribute to the Interior Design Body of Knowledge.

In chapter four, narrative inquiry is used in four case studies in order to identify intangible aspects of architectural spaces that influence human well-being. The intention is to get closer to the 'truth' about human experience, to raise awareness that interior spaces do impact human well-being, and that architecture can be regarded as a solution to satisfy

[1] '*Architectural spaces*' refers to the interior of architectural shells, usually called '*interior spaces*' by interior designers. Both terms are used throughout this text because the findings of this study are relevant to interior designers, architects, and others involved in the designing of spaces for human use.

needs of space users. Architect and theorist Christopher Alexander's (1979) notion of human feelings toward architectural spaces and the theoretical Model of Experiential Responses to Space are presented and serve as frameworks to test the hypothesis that people's moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit.

In chapter five, neuroscientific research is used to explore how the human brain can be impacted by architectural spaces. The goal is to increase awareness that neuroscience / human-behaviour / built-environment interrelationships can also be regarded as solutions to satisfy needs of occupants. This study exemplifies how the new field of neurosciences and architecture can be used to generate knowledge on how architectural spaces influence the well-being of humans. It draws on theoretical and conceptual frameworks such as Alexander's (1979) approach to 'subjective human feelings', Vischer's (2005) Environmental Comfort Model of User Space Interaction, as well as Zeisel's (2006) eight 'deep' healing design principles used for Alzheimer patients, which were applied to the design of the new offices for the Society of Neuroscience in Washington, D.C.

Chapter six uses a qualitative and a quantitative approach to explore some of the complex relationships between architectural spaces and their effects on humans. Integrating these two approaches in order to measure intangible aspects of architectural spaces is innovative and important because both methods complement each other. Quantitative data can be used to flesh out and expand the results of qualitative data analysis.

Chapter seven highlights the values in combining both research methods and how they contribute to the Interior Design Body of Knowledge (Guérin and Martin 2004). Similarities, differences, strengths and weaknesses of both methods are addressed as well as the importance of this research and its applications to design. The originality and contribution of this study are explained as well the importance of building ties between design and research professionals in order to further research that contributes to this knowledge base in interior design.

INTERIOR DESIGN BODY OF KNOWLEDGE

Environmental psychologists and interior designers aim at improving the built environment for the purpose of user self-fulfillment and well-being. According to the Foundation for Interior Design Education and Research (FIDER 2006), interior design is a multi-faceted profession in which creative and technical solutions are applied within a structure to achieve a built interior environment. These solutions are functional, enhance the quality of life and culture of the occupants, and are aesthetically attractive. Designs are created in response to and coordinated with the building shell, and acknowledge the physical location and social context of the project. Designs must adhere to code and regulatory requirements and encourage the principles of environmental sustainability.

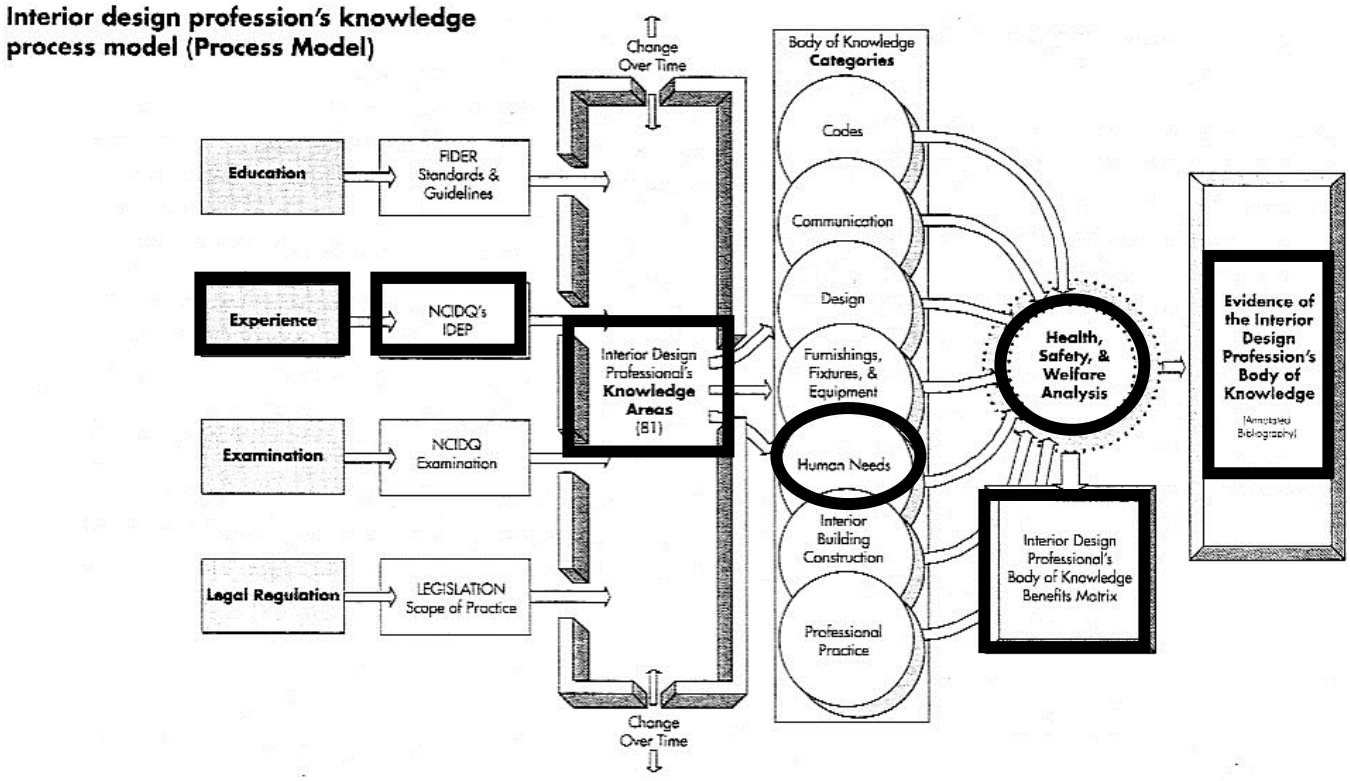

Figure 1-1 Interior Design Profession's Knowledge Process Model
(Guérin and Martin 2004)

The interior design process follows a systematic and coordinated methodology, including research, analysis and integration of knowledge into the creative process,

whereby the needs and resources of the client are satisfied to produce an interior space that fulfills project goals (FIDER 2006). Figure 1-1, The Interior Design Profession's Knowledge Process Model (Guérin and Martin 2004) indicates the knowledge areas of the interior design profession. The Human Needs as well as the Health, Safety, & Welfare Analysis categories are highlighted with darkened circles in order to show the general areas of investigation in the present research. Highlighted in dark boxes refers to the Experience part of this Process Model.

Table 1-1 shows a partial view of the Interior Design Body of Knowledge via Career Cycle and H/S/W Framework (Guérin and Martin 2004) which indicates the interior design body of knowledge in the far-left column and the career cycle in the middle columns. Both are in correlation with the benefits to the public concerning health, safety and welfare (H/S/W) that are represented in the far-right column. An arrow has been added to this table to highlight the fact that, in the Human Needs section, between Barrier-Free Design and Human Factors, boxes are not checked off in the Experience column. The Human Behaviour / Built Environment and Human factors boxes have further been highlighted to point out to the reader that these two categories represent a knowledge gap in the Interior Design Body of Knowledge (Guérin and Martin) and also represent the areas of study that are addressed in this research.

Though the area that this research refers to lies within the Experience column of the Interior Design Body of Knowledge via Career Cycle and H/S/W Framework (Guérin and Martin 2004) shown in Table 1-1, it is through continual building of research knowledge and the building of ties between design professionals and research groups that practitioners may better understand the advantage of using scientifically based research findings.

In order to contribute to the Experience part in the interior design body of knowledge, Alexander's (1979) theoretical frameworks are referred to throughout this research in order to relate to people's inmost '*feelings*' towards '*intangible*' environmental characteristics as a basis from which designers can support design solutions.

Body of Knowledge	Career Cycle				Benefits to the Public		
Categories / Knowledge Areas	**Education**	**Experience**	**Examination**	**Legal Regulation**	**H**	**S**	**W**
Lighting / lighting plans	❖	❖	❖	❖	X	X	X
Principles of design	❖			❖			X
Problem identification / solving	❖	❖		❖	X	X	X
Programming	❖	❖	❖	❖	X	X	X
Sustainable / green design	❖		❖	❖	X	X	X
Space planning (circulation/adjacencies)	❖	❖	❖	❖	X	X	X
Spatial composition / articulation	❖		❖	❖	X	X	X
Universal design	❖				X	X	X
Furnishings, Fixtures and Equipment (FF&E)							
Decorative elements / accessories and art (selection / application)	❖			❖			X
Finish plans / schedules	❖		❖	❖	X	X	X
Furnishings, fixtures, & equipment (FF&E) layouts and schedules	❖	❖	❖	❖	X	X	X
Furnishings (selection / specifications / performance)	❖	❖	❖	❖	X	X	X
Installation (methods / scheduling / supervision)	❖	❖		❖	X	X	X
Procurement/purchasing documents		❖		❖		X	X
Textiles (design / selection / technology)	❖	❖		❖	X	X	X
Human Needs							
Analysis (of data)	❖	❖	❖	❖	X	X	X
Barrier-free design / accessibility	❖		❖		X	X	X
Environmental health / indoor air quality (IAQ)	❖		❖		X	X	X
Function /functional requirements	❖		❖	❖	X	X	X
Global perspective (cultural / political / economic / social)	❖				X	X	X
Human behaviour (psychological and sociological factors) / built environment interrelationship	❖		❖	❖	X	X	X
Human factors (ergonomics E anthropometrics /proxemics)	❖		❖	❖	X	X	X
Needs / requirements / issues (users / clients)	❖	❖	❖	❖	X	X	X
Post-occupancy evaluation (POE)	❖	❖	❖	❖	X	X	X
Research / research methods	❖	❖		❖	X	X	X

Table 1-1 **Interior Design Body of Knowledge Via Career Cycle and H/S/W Framework** (Guérin and Martin 2004)

When problems continuously occur in our environment, core solutions can be found and can be applied in various ways. This is part of a pattern language that Alexander (1975, 1977 and 1979) extrapolates as making us feel good because some patterns help make us whole and we feel more at one with ourselves in their presence.

For example, in terms of architecture, patterns define qualities a building must have to meet human needs and 'feelings' provide a powerful way of finding out just which building patterns are balanced and which ones are not.

The desirable outcome of this research would be to bring design practitioners into closer collaboration with research teams in different stages of their projects in order to capture subjective user feelings that will bring to light issues worthy of finding design solutions to and that are geared towards human well-being.

HUMAN BEHAVIOUR / BUILT ENVIRONMENT RELATIONSHIP

Studies in Environmental Psychology pertain to residential, urban, educational, hospital, workplace, and natural environments, just to name a few. Subjects that relate to human behaviour and the built environment include personality and environment, personal space, territoriality, crowding, privacy, perception, cognition, as well as environmental attitudes, appraisals and assessments all with their sub-categories such as social design, indoor climate, air, light, colour, windows, density, arrangements, pollution, etc. Environmental Psychology is a relatively new field that addresses scientific principles and practical applications as it seeks to improve problems due to person / environment reactions. More precisely, Environmental Psychology is the study of transactions between individuals and their physical setting (Gifford 2002) where theory, research and practice aim at improving the relationship between humans and the environment within which they live, work or play.

In this study, the human behaviour / built environment relationship is seen through the concept of intangible aspects of architectural spaces and how these influence human

well-being. Concepts such as ‘Sense of Place’ (Abbate 2005) as well as how the built environment can influence mood, well-being and emotions can provide theoretical frameworks for the present research.

Intangible Aspects of Architectural Spaces

Throughout history humans have developed shelters to protect themselves from natural phenomena. These shelters have grown from simple protective shells, providing convenience for daily activities, to places where comfort and psychological well-being have become essential commodities that influence our experiences and in turn influence our actions and emotions. More than a compromise between use and beauty, today we have come to realize that the effects of architectural spaces have an incredible influence over our state of mind. Furthermore, feelings of satisfaction and well-being within architectural spaces have grown to be important issues and as designed environments progress to become more complex, new areas of specialization will continue to develop. As was seen through the Interior Design Body of Knowledge via Career Cycle and H/S/W Framework (Guérin and Martin 2004) shown in Table 1-1, health, safety and welfare of the public are important considerations to take into account while designing architectural spaces.

Studies of human behaviour / built environment relationships often tend toward single aspects of environmental characteristics, such as colour or light, in reference to human well-being. Intangible aspects are rarely mentioned in association with overall ambiance derived from designed spaces. When collecting data, subtle needs that represent individual feelings that one experiences are often left out as they can only be ‘felt’ by participants and are not necessarily easily expressed in words (Alexander 1975) or valued by the researcher.

For example, color can have a profound effect on an individual's moods and feelings (Hutchings 2006). Designers can exploit these effects to provide spaces in which one can live with minimal stress and optimal comfort. In working with scientists, research tools to discover and quantify links between physical design and the feelings of the viewer can be

very useful to space planners in helping them better understand the designed environment's effect on the space user. The Total Appearance Concept, originally developed to make foods look more appetizing, can certainly be beneficial to wider areas of design in general (Hutchings 2006). This concept is based on a quantitative understanding of four image types (the basic perceptions of form, color, translucency, gloss, and movement) which play a large part in directing and controlling human behavior (Hutchings 1995).

Hamid and Newport (1989) examined the effect of warm-pink and cool-blue colored environments on gross motor activity and mood in 6 preschool children (aged 50-55 months) in New Zealand. During the 8-week experiment, participants were assessed for up to 7 days under each color condition and under a gray (control) condition. Physical strength was measured by a modified ergometer, and mood was measured by judges' ratings of participants' paintings. It was found that participants displayed greater physical strength and produced highly positive mood paintings under the pink condition as compared with the blue condition; the control condition had intermediate effects. Results suggest that a pink room probably increases general arousal in children.

Studying intangible aspects of architectural spaces may be useful in finding out how phenomena such as peoples' performance or mood can be affected by them. But because environments are composed of multiple characteristics that have an influence on space users, a more holistic approach needs to be used. Humans are affected by all aspects of a space, which are intertwined together to form a whole. We must seek further than individual aspects of interior spaces such as a light source, or a specific colour, or a decibel level that affects ones moods and behaviours. Research is needed into how entire spaces affect user feelings; a more holistic approach can enable the study of entire spaces that are composed of multiple environmental characteristics which, together, constitute intangible atmospheres.

Anthony C. Antoniades (1992), in his 'Poetics of Architecture', addresses intangibles by exploring the fundamental theories of Modern and Postmodern design. He

attempts to reconcile all that is worthwhile in these two movements into a new attitude toward architecture. He explores the intangible and tangible channels that one can harness in creating architectural design and guides readers towards producing designs that are richer on spatial, sensual, spiritual, and environmental levels. Some of the intangible channels to creativity he explores include fantasy, metaphor, the paradoxical and metaphysical, the primordial and untouched, poetry and literature, and the exotic and multicultural. Among the tangible channels covered are history and the study of precedents, mimesis and literal interpretation, geometry, materials, and the role of nature.

Alan Holgate (1994), in his 'The Art in Structural Design', goes beyond a strictly objective treatment to consider *intangible* 'real world' factors that also influence design, including political considerations, economics, the traditional organization of the industry, and the functional needs of the client. He considers architecture and aesthetics together with the relationship between the architect and the engineer.

Suzi Chiazzari (1998), in her 'The Healing Home. Creating the perfect place to live with color, aroma, light and other natural elements', describes energies being stored within buildings and that many people are sensitive to these vibrations. When people enter a room they can pick up the lingering atmosphere that may be peaceful and calming, or sorrowful and uncomfortable.

Jonathan Hill (2006), in his 'Immaterial Architecture', explores the forces that draw architecture towards the material or the immaterial where these are woven together and are in conjunction with each other and not in opposition.

Hill (2006) stipulates that:

> Immaterial architecture is the perceived absence of matter rather than the actual absence of matter. As the architect conceptualizes a design, this design remains immaterial. And it is not until the building is built and inhabited that the user can then make a decision as to whether the architecture is immaterial. Therefore immaterial is largely dependent on user

> perception and the goal is to attain a resulting extraordinary architectural experience. (p. 3)

Abbate (2005) refers to *sense of place* as being difficult to define because of its intangible nature of perception, memory, as well as associations and recollections all of which are perceived through our senses. He refers this to '*knowing it when you see it or sense it*'. *Extraordinary architectural experiences* are those that elicit the power and reality of first-person exceptional aesthetics and remarkable area of human experience (Bermudez 2008).

Abbate (2005) articulates that:

> Paris, New Orleans, or Taos, New Mexico are all known for having a strong sense of place, primarily because of the intense identity each city evokes, though it's hard to put the essence of each into words. (p. A5.1)

Lynch (in Abbate 2005) correlates '*sense of place*' with '*identity*' stating that:

> Sense of place is the extent to which a person can recognize or recall a place as being distinct from other places and possesses a character of its own. (p. A5.1)

Julio Bermudez (2008), in his 'Phenomenological Studies of Extraordinary Architectural Experiences', developed a research project named Architecture Live, that involves the study of extraordinary architectural experiences, or what he states as being '*transformative phenomenologies of the architecturally sublime*' that can help to understand the deep physical, perceptual, emotional, intellectual, and spiritual processes supporting our profound experiences of architecture and place. Architecture Live explores how physics (substance and materiality) and metaphysics (consciousness and psychology) affect one another and offer exceptional interfaces between mind and matter.

Bermudez (2008) explored Vitruvius's three principles of architecture which are firmness, commodity and delight (Morgan 2005). He claims that though firmness and commodity have been addressed through structural and technological implications as well

as socio-cultural and functional aspects providing support to human activities, delight which relates to the pleasing experience that a building's beauty may elicit, has remained elusive. The reason for this is that *delight* is intangible, qualitative, experiential and even viewed as esoteric and leaves our understanding of *delight* unclear.

Bermudez's (2008) research proposes that *realizing the nature of delight* needs to go no farther than our own **'***live'* experience of architecture, and that it may be greatly facilitated by studying the most dramatic cases available: *extraordinary architectural experiences***.** Hence, instead of being indifferent to the power and reality of first-person exceptional aesthetics, his research on Architecture Live investigates this little acknowledged, yet remarkable, area of human experience. He designed and conducted a one-year on-line survey, collecting nearly 3,000 personal accounts by asking participants to define three main outcomes from their experiences (Bermudez (2011). While results confirm an appreciation of beauty, sense of fulfillment and well-being, experiencing the architectural extraordinary also brings attention to their mental or cognitive effects.

Although normal experiences of architecture and place have already been addressed, there is little work on extraordinary aesthetic events (Franck 1979, Jones 2000). Literature consistently refers to sense of well-being, intuitions of place, self and life; space-time perceptual abnormality; and the transcendence of language and culture (Alexander 1979, Lobell and Kahn 1979, Zumthor 2010, Bertoni 1999). Even when architects observe this matter, they stay analytical and detached, and therefore overlook the empirical nature of these incidents (Norberg-Schulz 1985, Yoo-Jin 1997, Krinke 2005).

To reinforce the fact that intangible aspects of architectural spaces influence the well-being of humans, other studies concerning extraordinary architectural experiences are ongoing. A study in progress is aimed at collecting qualitative information about people's most profound, lasting, and / or intense reactions toward architecture (Bermudez 2008). A sample gallery of drawings is used as a phenomenological method to initialize, stabilize, appreciate, study, and record the experience of being present through architecture. There is *an* International Scholarly / Research Forum composed of individuals interested in the

relationship between architecture, culture and spirituality as well as a course which examines meta-cognitive, affective, and representational methods enabling a phenomenological realization of architecture, self, and beyond (Bermudez 2008).

Built Environment Influence on Human Moods: Lighting and Color

Studies that relate to mood in relation to the built environment include those such as mood ratings related to preferences to natural and built environments (van den Berg, Koole et al. 2003); effects of office interior colour on workers' mood and productivity (Kwallek, Lewis et al. 1988); and testing the effects of color and lighting modification in elementary schools on blood pressure and mood (Wohlfarth and Gates 1985).

Environmental preferences were tested against preference and mood (van den Berg, Koole et al. 2003). One hundred and six participants, of approximately 22 years of age, were shown a frightening movie and then viewed a video of either a natural or a built environment. Participants' mood ratings were assessed through two examples of each type of environment before and after they viewed the frightening movie, and again after viewing the environmental video. Participants rated the beauty of the environment and performed a test of concentration after having viewed the environmental video. Results show that participants viewing natural environments elicited greater improvement in mood and marginally better concentration than viewing built environments.

In another study 36 adults performed a typing task in either a red or blue office environment and were asked to complete a questionnaire (Kwallek, Lewis et al. 1988). Alternating typing and questionnaire forms, this method was then repeated in either a different-colored office or in the same one. Results demonstrate that participants who remained in the same-colored office made less typing errors than those who moved to a different-colored office. Depression scores were higher for participants who remained in the blue office while those who remained in the red office anxiety and stress scores were higher. On the other hand, arousal scores were higher for participants who repeated the required tasks in different offices.

In another study participants were chosen from four Canadian schools, including principals, teachers, and randomly selected students from grades two to six (Wohlfarth and Gates 1985). A total of 6,120 blood pressure measures were collected and students also completed a mood scale. The artificial lighting was changed to full-spectrum fluorescent light in one school, new psycho-dynamically selected colors were selected to repaint classrooms in another school, colors and lighting were changed in the third school and the fourth school served as control. Results indicate that in the third school, with the change in color and lighting, students showed significantly lowered blood pressure but not teachers or principals. The most significant increase in self-esteem resulted with the participants of this same school as well as a decrease in sadness and aggression on pre- and post test measures of mood.

These few examples demonstrate that certain aspects of the environment do affect mood and that further research to address several environmental characteristics that compose architectural spaces in relationship to human behaviour has tremendous potential. It is the field of spatial relationships within an environment that make atmospheres possible (Alexander, 1979) therefore, during the design process, giving thought to wholeness of spaces that bring forth positive moods may certainly enhance human well-being.

As space planners design beautiful, poetic and functional spaces for humans, they must involve the end user in the different phases of a project in order to better understand which underlying environmental characteristics better respond to specific human needs. Designed spaces are composed of environmental characteristics that, together, create general atmospheres that affect human behaviour and well-being. Therefore, research must address holistically environmental characteristics that affect human well-being. It must address whole atmospheres as these affect space users' mood, ability to focus attention and stress levels.

Built Environment Influence on Well-Being

The notion of well-being is a fairly large area of investigation. Therefore, an overview of studies that relate to this subject is depicted in order to situate the reader.

The concept of well-being refers to optimal psychological functioning and experience (Ryan and Deci, 2001). Research has tended to fall into two general groups of well-being. First, the 'hedonic' viewpoint focuses on subjective well-being (SWB) and is associated with happiness and is formally defined as more positive affect (affect meaning: feeling or emotion), less negative affect, and greater life satisfaction (Diener and Lucas 1999). In contrast, the 'eudaimonic' viewpoint focuses on psychological well-being, which is defined in terms of the fully functioning person and has been functioning either as a set of six dimensions (Ryff 1989), as happiness plus meaningfulness (McGregor and Little 1998), or as a set of wellness variables such as self-actualization and vitality (Ryan and Deci 2000). Basically, the relation of emotions to well-being deals with the meaning of well-being itself (Ryan and Deci 2001).

Research on emotions and SWB (subjective well-being) has elicited that (a) people continuously experience affect; (b) affect is balanced and easily judged as positive or negative; and (c) though most people report having positive affect most of the time (Diener and Lucas 2000), it is still unclear how much effect actual live events have on well-being. The eudaimonic position, in contrast to the hedonic view, suggests that the important issue concerning emotions is not feeling positive per se (Parrott 1993), but rather is the extent to which a person is fully functioning (Rogers 1963).

From a eudaimonic view, such issues as the repression, disclosure, compartmentalization, and over-control versus under-control of emotions are highly pertinent to what defines wellness. For instance, research reviewed by King and Pennebaker (1998) suggests that suppressing or withholding emotions has clear costs for psychological and physical health. Furthermore, DeNeve and Cooper (1998) found that people high in repressive tendencies tend to have lower SWB (subjective well-being). Conversely, there seem to be well-being benefits to emotional disclosure (Butzel and Ryan 1997). Such findings fit the claims of eudaimonic theorists that expressing emotions derived from experiences are important for well-being.

Another line of eudaimonic research on emotions suggests that, because emotional positivity is not part of the definition of well-being, affect can be studied as an outcome of eudaimonic processes. Ryff and Singer (1998) emphasize that positive relationships were found to be particularly strongly related to positive experiences. These researchers viewed emotions as a catalyst to health states and they focused on the capacity of deep emotional experience to mobilize antistress and disease resistant functions. Strauss and Allen (2006) observed the rapport between attention bias for positive emotional words and self-reported emotional experience. Their findings reveal that participants who experience low levels of negative emotion and high levels of positive emotion demonstrate an attention bias for positive information while providing insights in the way that positive emotions broaden cognitive processes. Using research on emotions from a eudaimonic perspective has examined psychological conditions that promote positive emotions, including happiness and vitality.

Ryff and Singer (1998) refer to sickness as being often associated with displeasure or pain where the presence of illness might directly increase negative affect. Therefore health status and well-being are associated when it seems apparent that continual illness may present functional restrictions, which can eventually detract from life satisfaction.

Cowen (1991) suggests that wellness should be defined as an array of positive aspects of functioning that are promoted by attainment of strong attachment relationships, acquisition of age-appropriate cognitive, interpersonal, and coping skills, and exposure to environments that empower persons. For example, smells and sounds can enliven a room therefore the smell of flowers and gardens might be brought inside our living spaces (Alexander, Ishikawa et al. 1977). Work on well-being indicates that the meaning of well-being, the conditions that engender it, and how it differs across place or time is yielding a rich and varied knowledge on human wellness.

Many characteristics influence the welfare of people and it is of utmost importance that professionals who design spaces for the use of humans take into account these factors. Research to find out more about subjective issues relating to human behaviour and the built

environment may reveal data that will be useful to professionals who design spaces. Creating spaces that heighten emotional experiences reward users who experience positive affect that influences their well-being.

INFLUENCE OF ARCHITECTURAL SPACES ON HUMAN WELL-BEING

Humans are surrounded by elements of the environment in ways that are neither direct nor explicit, in this thesis an understanding of how intangible aspects of architectural spaces influence human well-being are explored. Chiazzari's (1998) approach to 'environments that promote good health', Abbate's (2005) 'key attributes to successful places' and Vischer's (2005) frameworks that support user 'comfort' and 'satisfaction' illustrate that environmental characteristics that provide positive affects to space users also provide the basis for users' long-term well-being. Alexander's (1977, 1979) 'approach to subjective human feelings' is also explored as a way to access human experiential material.

Environments That Promote Good Health

As our homes are reflections of ourselves (Cooper Marcus 1997), a well balanced place of living, working or playing may hold the key to sustaining happiness which is the basis for a long and healthy life. Initially not all buildings are positive, healthy places to be.

Chiazzari (1998) articulates that:

> Both occupants and buildings may produce negative energy in the spaces within which they live, and harmful vibrations can originate from the exterior, especially from the earth over which spaces are built. Basically three types of toxic vibrations can be formed in the home and these can come from external as well as internal forces. The first being negative vibrations left by people who have occupied the space. The second relates to the building, the furniture, the furnishings as well as the equipment in it. And the third relates to exterior conditions. (p. 47)

Since the earth has its own magnetic field, certain places that have strong energy zones also have powerful healing properties. But when the natural electromagnetic field in

the ground is disturbed, energy can become distorted, creating geopathic stress that can be caused either by natural phenomena or by high-voltage power lines and electric man-made materials. Buildings built over areas of magnetic stress expand and contract during a full moon when the earth vibrations are at their strongest (Chiazzari 1998).

In relationship to these natural forces, the way we set up our homes in order to make ourselves more comfortable may not be the same way we set up our work environments. On the contrary, if a person is sensitive to certain environmental characteristics in their home, they will also probably be sensitive to those same environmental characteristics in other architectural settings. Therefore, it is important to raise awareness that what may be good for people in residential settings may also be good for other settings when investigating the influence of architectural spaces on human well-being.

Bad environmental conditions do have a direct influence on decrease in concentration and motivation which can lead to a critical outlook and depression resulting in health problems in the long run (Chiazzari 1998). Just imagine the sun's glare on the computer screen, having teens play loud music as a parent is trying to get office work done, a person squinting to read because light conditions are too low, having a hard time finding an intimate spot to relax during lunch, or having to put on heavy sweaters in the office because the temperature is too cold. There are several environmental factors where comfort levels differ from one person to another. And if a building is to be a comfortable refuge, user control over these factors is essential to ensure user comfort (Rousseau and Wasley 1999).

Though the intangible atmosphere generated through architectural spaces may be difficult to describe, it is this less apparent realm that may be affecting user health. Though healthy buildings are not designed solely for sick people, it is those intangible aspects of architectural spaces that should be dealt with no matter what the space is used for (Rousseau and Wasley, 1999). Whether it is for residential, commercial or leisure purposes, buildings should be intentionally designed as healthy environments that promote good health.

Rousseau and Wasley (1999) stipulate that:

> Good design recognizes that health is much more than the absence of disease. It is also a sense of well-being supported by life-affirming conditions of light, comfort, space, colour, and usually has access to natural elements such as plants, trees, earth, stone, wood and water. (p. 6)

It is to be anticipated that healthy building practices should be applied to all designed spaces including residential settings, work places, schools and other buildings where control over environmental characteristics such as lighting, air quality, noise and privacy can improve occupant satisfaction, productivity and reduce sick time (Rousseau and Wasley 1999). But even more important to consider is that multiple environmental characteristics are present in architectural settings and it is these that form atmospheres which affect user well-being. Users may respond positively to architectural settings that make them happy and make them feel a sense of well-being. They may also respond negatively to those architectural settings that make them feel stressed or feel in a bad mood.

Key Attributes of Successful Places

The connection between humans' need for a sense of place and identity and the design of the built environment requires planning to be viewed as a creative process where the environment, transportation systems and the community are essential components in achieving a unique sense of place (Abbate, 2005).

Abbate (2005) stipulates that:

> To respond to a unique sense of place, local design activity can develop according to four general criteria:
>
> 1. Connection with the natural landscape
> 2. Use of indigenous materials
> 3. Design for the climate
> 4. Integration of multiple modes of transport. (p. A5.10)

Abbate (2005) also stipulates that:

> The experience of a place can be described in seven stages of engagement or movement: (p. A5.10)

1. Orientation

   It occurs as one approaches a place and gives a sense of anticipation, based on perceptions, memories or knowledge about that place. (p. A5.10)

2. Approach

   It occurs as one enters a place where recognition offers first suggestions of the character of the place being favourable or unfavourable. (p. A5.10)

3. Threshold

   It occurs at the moment of entry where awareness can be experienced based on cues such as signage, materials used, architecture and landscaping. (p. A5.11)

4. Arrival

   It occurs once one has entered the centre of a place, which differs from the periphery or the edge of a place. (p. A5.11)

5. Docking and Wayfinding

   It occurs when one transits from being a motorist or passenger to becoming a pedestrian. (p. A5.11)

6. Circulation

   It occurs when one experiences the stroll, the search, and the walk from place to place. Movement will depend on the optimal mix of comfort, security, and stimulation. This phase is not solely influenced by the design of the physical environment, but by the coordination and quality of business and commercial activity, and a feeling of spontaneity and authenticity generated by a diverse mix of local culture: art, music, performance, cuisine, and handcraft. (p. A5.11)

7. Departure

   It is facilitated by awareness and ability to leave by the most convenient means. An easy and seamless departure experience will reinforce a positive impression of a place or community. This stage of place experience will ultimately affect the memory of a place, taking the form of a combination of a special landscape, an architectural feature, clear signage, or public art. The departure sequence starts with orientation toward the boundary, approach to the threshold, and ultimately exit from the place or community. Just as a clear signification is made of entry, exit is an important part of the experience of place. (p. A5.12)

Table 1-2, Key Attributes of Successful Places (Abbate 2005), shows that attributes and intangibles of 'comfort and image', 'access and linkage', 'uses and activity', and 'sociability' are linked to measurement tools. These can all be linked to the seven stages of engagement or movement (orientation, approach, threshold, arrival, wayfinding, circulation and departure) that constitute the experience of a place.

For example, if participants feel comfortable with the image of the environment that they see, it may be because they feel well oriented and feel free to circulate as they wish. This may give them a sense of safety where they may want to sit for a while and enjoy the nature and cleanliness of the place. Building conditions may have been the reason why participants felt safe and therefore wanted to sit in that area.

Table 1-2, is useful as it identifies specific types of intangibles that can be assessed through key attributes to successful places. It is shown to represent that intangibles do exist and that they can be linked to attributes and measurement scales as illustrated in Abbate's study (2005) and can also be accessed through other research methods such as narrative inquiry and neuroscientific research that will be used for the present thesis.

Abbate's (2005) Key Attributes of Successful Places as shown in Table 1-2 show how human well-being can be affected by many aspects such as physical, functional, psychological and social environmental characteristics. Though intangible outcomes may

vary accordingly, there are still key elements that designers can be aware of in order to plan successful places for user comfort and long-term well-being.

KEY ATTRIBUTES OF SUCCESSFUL PLACES			
	ATTRIBUTES	**INTANGIBLES**	**MEASUREMENTS**
COMFORT AND IMAGE	Safety Charm History Attractiveness Spirituality	Sittability Walkability Greenness Cleanliness	Crime statistics Sanitation rating Building conditions Environmental data
ACCESS AND LINKAGE	Readability Walkability Reliability Continuity	Proximity Connectedness Convenience Accessibility	Traffic data Mode split Transit usage Pedestrian activity Parking usage patterns
USES AND ACTIVITY	Realness Sustainability Specialness Uniqueness Affordability Fun	Activity Usefulness Celebration Vitality Indigenousness '*Native*' quality	Property values Rent levels Land-use patterns Retail sales Local business ownership Environmental data
SOCIABILITY	Co-operation Neighbourliness Stewardship Pride Welcoming	Gossip Diversity Storytelling Friendliness Interactivity	Street life Social networks Evening use Volunteerism Number of children, and elderly

Table 1-2 Key Attributes of Successful Places (Abbate 2005)

For example, though '*attributes*' and '*intangibles*' can be rated with measurement tools such as '*crime statistics*' to get a sense of '*COMFORT AND IMAGE*', attributes such as 'safety', when related to the '*intangible*' notion of '*sittability*', can be derived from '*physical'* characteristics such as a park bench where one feels comfortable sitting in a reputable park in the city, or such as views to the outside where we may sit and see elements of nature to get a feeling of connectedness (Alexander, Ishikawa et al. 1977).

Just the same as when '*attributes*' and '*intangibles*' are rated with measurement tools such as '*pedestrian activity*' to get a sense of '*ACCESS AND LINKAGE*', attributes such as '*walkability*', when related to the '*intangible*' notion of '*convenience*', can be derived from '*functional*' characteristics such as a well lit and well identified walkway where one has easy access to the coffee shop during lunch hours.

When '*attributes*' and '*intangibles*' are rated with measurement tools such as '*property values*' to get a sense of '*USES AND ACTIVITY*', attributes such as '*affordability*', when related to the '*intangible*' notion of '*celebration*', can be derived from '*psychological*' characteristics. For example, a person could feel a sense of celebration after having purchased an affordable property that he or she can make good use of by incorporating multiple activities that can hence raise the value of their property.

And when '*attributes*' and '*intangibles*' are rated with measurement tools such as '*social networks*' to get a sense of '*ACCESS AND LINKAGE*', attributes such as '*neighbourliness*', when related to the '*intangible*' notion of '*friendliness*', can be derived from '*social*' characteristics such as a friendly neighbourhood where home owners exchange on a regular basis as a means of generating a convivial social environment that is comfortable to reside in.

Both Chiazzari's (1998) approach to environments that promote good health as well as Abbate's (2005) key attributes to successful places, offer opportunities to understand how user comfort and satisfaction may also set precedents for user long-term well-being.

User Comfort and Satisfaction

Comfort: In the field of environment and behaviour, the concept of comfort is used to describe users' experiences in office buildings where physical comfort combined with functional comfort and psychological comfort results in a positive effect on morale and performance (Vischer 2005). In Vischer's model, physical comfort can be described as affecting health and basic convenience and is expressed through codes, standards and norms for building safety and health. These include such aspects as transportation access,

parking, adequate elevator service and toilets, light, air, thermal comfort, noise as well as effective maintenance and repair services. On the other hand, functional comfort can be described in reference to aspects such as appropriate lighting for screen-based work, ergonomic furniture for computer users and enclosed rooms available for meetings and collaborative work. These link the physical qualities of the environment with the tasks performed by users. Psychological comfort on the other hand can be described in reference to feelings of belonging, ownership and control over workspace (Vischer 2005). For example, it can be said that any place where people can feel comfortable has a back and a view into a larger space (Alexander, Ishikawa et al. 1977).

Vischers' (2005) model of How Environmental Comfort Works shown in Figure 1-2 indicates that physical, functional and psychological comfort are combined together to create a positive effect on morale and performance. This model shows that a functionally comfortable workspace can be used as a tool for work.

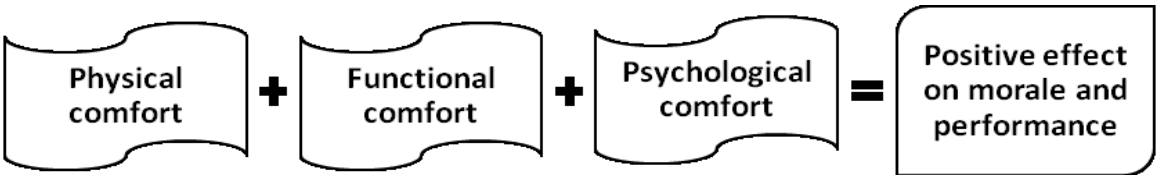

Figure 1-2 How Environmental Comfort Works (Vischer 2005)

Since the 1980s', studies have been conducted using the Building-In-Use (BIU) Assessment Questionnaire to measure the functional comfort dimensions in office environments (Vischer 2005). BIU feedback from office occupant surveys in Canada and United States have generated basic dimensions of environmental comfort where users evaluate environmental effects on job performance. This tool is used to collect performance-linked feedback from users on air quality, thermal comfort, spatial and workstation comfort, privacy, lighting and day lighting comfort as well as acoustic comfort (office noise and building noise).

Vischer's (2005) Functional Comfort Dimensions shown in Table 1-3 suggest that Environmental Items Rated by Occupants are also considered intangible even though they derive from tangible elements.

Comfort Category	Environmental Items Rated by Occupants
Air quality	Air freshness Air movement Ventilation comfort Feeling warm
Comfort	Feeling cold Temperature shifts Drafts Feeling warm
Spatial Comfort Subcategories: Workstation / furniture comfort Collaborative workspace	Amount of space Furniture comfort Work and personal storage Work surface dimensions Places to meet visitors Places to work together
Privacy	Hearing others and being overheard Seeing others and being seen Telephone privacy
Lighting Quality Subcategories: Day lighting Visual comfort	Lights too bright Glare Proximity to windows Light from windows Not enough light
Office noise control	Noise distractions General background noise Voices and equipment noise
Building noise control	Air systems noise Noise from outside the building Buzzing lights

Table 1-3 Functional Comfort Dimensions (Vischer 2005)

For example, in the Comfort Category, Air quality can be related to *air freshness* that could mean windows that open. And Lighting Quality can be related to *lights too*

bright because of a light fixture that is not suited for a particular task. Together, elements of comfort and satisfaction go hand in hand in order to respond to user fulfilment.

Satisfaction

If a person feels comfortable in their surroundings, their sense of satisfaction may well be a function of that level of comfort. This can be exemplified in Figure 1-3, the Hierarchy of Needs (Maslow, in Norwood 2006) and in Figure 1-4, The Habitability Pyramid (Preiser and Taylor 1983, Vischer 2005). In both cases a theory is offered of how humans can reach full potential and self-actualization or satisfaction and well-being in the built environment.

In reference to self-realization, the American psychologist Abraham Harold Maslow proposed the Hierarchy of Needs in his book *Motivation and Personality* in 1943. In Figure 1-3, Hierarchy of Needs, Maslow (in Norwood 2006) depicts five categories of needs and uses a pyramid to illustrate that a need grows based on the lower needs. At the bottom of his pyramid are depicted basic physiological needs such as warmth, shelter and food and at the top are depicted needs of self-actualization such as reaching one's full potential, which can be interpreted as a state where one is fully satisfied. Security needs such as protection from danger, followed by social needs such as love, friendship and comradeship, followed by ego needs of self respect, personal worth and autonomy fill the centre of the pyramid.

This can be used as a springboard to understand The Habitability Pyramid (Preiser and Taylor 1983, Vischer 2005) shown in Figure 1-4. This pyramid shows that physical comfort is based on necessities such as building codes and safety standards, whereas functional comfort is based on measuring users' performance, and psychological comfort is based on emotional needs and the control a user has over his or her environment. Since *habitability* is measured by occupant satisfaction (Gifford 2002), the habitability threshold is situated right below the physical comfort zone where anything below this is considered being in the '*discomfort*' area of the pyramid. Therefore, the higher the environment escalates on this pyramid to include basic needs, performance and control the more users reach a level of satisfaction and well-being within the work environment.

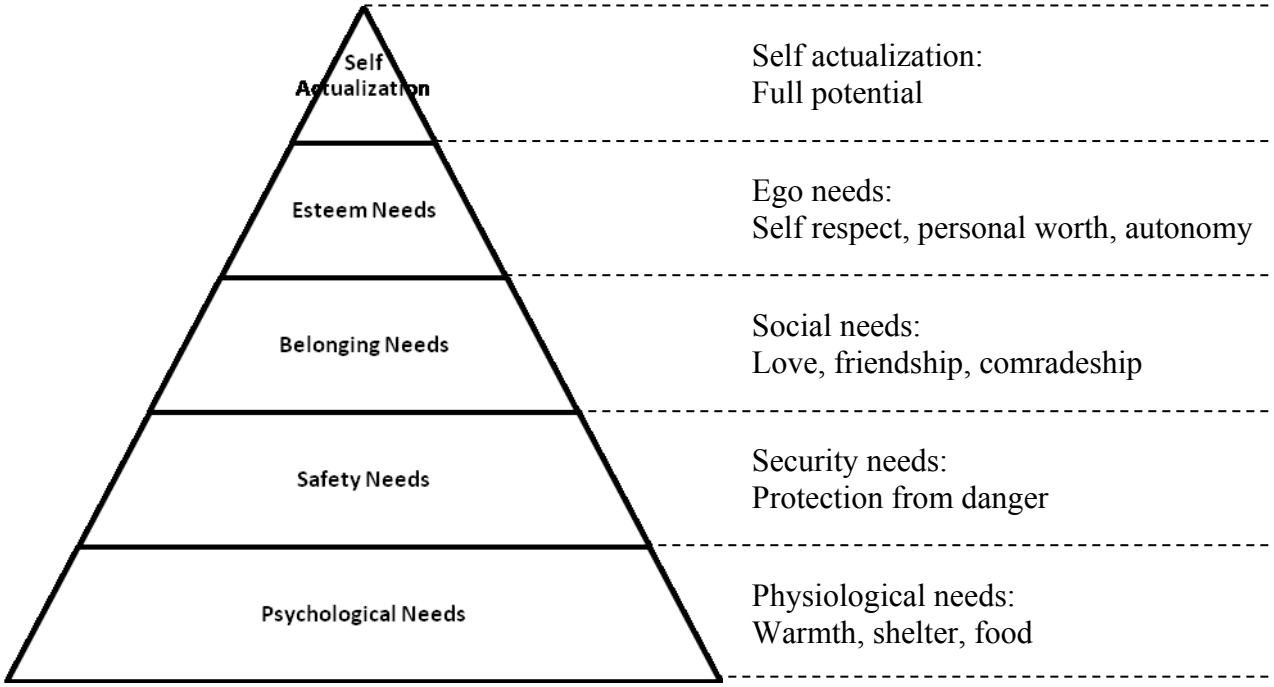

Figure 1-3 Hierarchy of Needs (Maslow, in Norwood 2006)

User satisfaction is connected to this model since The Habitability Pyramid (Preiser and Taylor 1983, Vischer 2005) shown in Figure 1-4 demonstrates that investment decisions based on basic physical necessities, as well as functional and psychological comfort improve productivity. Furthermore, the habitability pyramid demonstrates that investment decisions that are intended for user performance and wellness also aim at design decisions that gear towards user satisfaction and well being (Vischer 1989).

Figure 1-3, Hierarchy of Needs (Maslow, in Norwood 2006) and Figure 1-4, The Habitability Pyramid (Preiser and Taylor 1983, Vischer 2005) demonstrate how humans can feel a level of satisfaction and well-being within the environments within which they live and work.

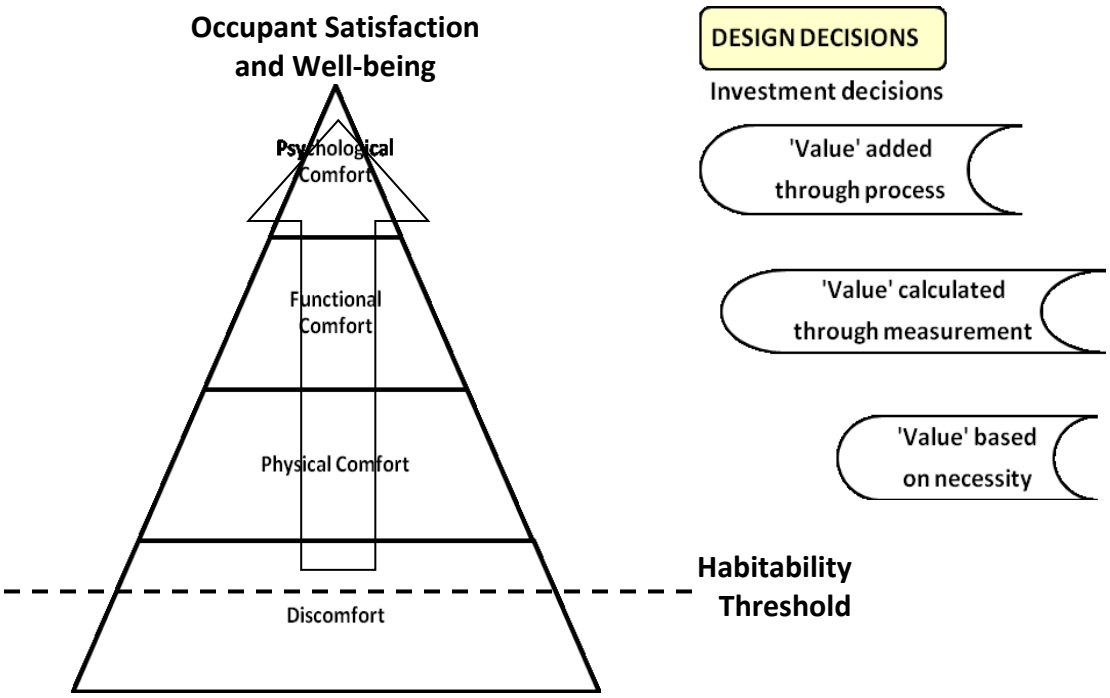

Figure 1-4 The Habitability Pyramid
(Preiser and Taylor 1983, Vischer 2005)

Alexander's Approach to Subjective Human Feelings

In reference to the notions of comfort and satisfaction, 'the solidity of subjective human feelings' as a scientific approach may add value to preconceived concepts and opinions (Alexander 1979). Furthermore, using a holistic approach to find out how people 'feel' about the spaces within which they live may provide designers with more opportunities to plan spaces that generate atmospheres that are conducive to human well-being.

Though at times single aspects of environments may be depicted as influencing human reactions it is often the whole surrounding composed of multiple elements that are unspoken, indescribable, or intangible, that influence human responses. For example, Alexander and Ishikawa (1977) have shown that in large office buildings people were found to complain about the general atmosphere; due to the human requirement for natural light, people all over the world rebel against windowless buildings or they complain of

having to work in places without daylight; People are in a more positive frame of mind in rooms with windows than in rooms without windows (Alexander, Ishikawa et al. 1977). According to scientific and industrial research in architectural physics, too much artificial light creates a rift between a person and his surroundings and upsets the human physiology (Rapoport 1967); The shape of a building has a great effect on the relative degrees of privacy and overcrowding in it, and this in turn has a critical effect on people's comfort and well-being (Alexander, Ishikawa et al. 1977); There is widespread evidence to show that overcrowding in small dwellings causes psychological and social damage (Landler 1954; Loring 1956; de Lauwe 1959; Alexander, Ishikawa et al. 1977); Movement between rooms is as important as the rooms themselves and the spatial arrangement has as much effect on social interaction in the rooms as does the interiors of the rooms (Alexander, Ishikawa et al. 1977). A place inside an entrance room (a reception) must be built with an atmosphere that will make people feel welcome; The atmosphere plays a crucial role for any space, whether it is intimate or public; Details such as balconies, a sunny place, light on two sides of every room, connection to the earth…are all aimed at creating positive spaces where people can enjoy themselves; Social distance is related to issues of intimacy or non-intimacy (Alexander, Ishikawa et al. 1977).

In the light of these findings it is essential to design spaces that favour human and social development rather than aesthetic value (Fischer 1983). Humane environments are alive and inhabited by daily multiple activities. And space planning has come to realize a new responsibility which Fischer (1983) calls '*le potentiel qualitatif d'un espace*' translated as, '*the qualitative potential of a space*' where six functions can be used as a base for space planning. Fisher (1983) states these intangibles as:

1. l'abri et la sécurité (shelter and security);
2. le contact social (social contact);
3. l'identification symbolique (symbolic identification);
4. l'instrumentalité relié à la tâche (instrumentality related to the task);
5. le plaisir (pleasure);

6. la croissance (self fulfillment).

These relate to the Hierarchy of Needs (Maslow, in Norwood 2006), illustrated in Figure 1-3, and to environmental competence (Pedersen 1999), meaning that an individual has control over the changing of his or her environment rather than having to adapt to it. As architectural environments are places to live, the architectural intervention has become more and more one of technical problem solving, of social concern and one of humanization of work environments for today and tomorrow. Therefore intangible elements of architectural spaces must be taken into consideration when designing spaces. These shape human responses that in turn affect human moods and can either be expressed as feelings of comfort or discomfort and ultimately as feelings of satisfaction or dissatisfaction.

SUMMARY

Humans must feel comfortable and in control of their immediate environment in order to be well. And if a building is to be a comfortable refuge, it is essential that space planners and space users control the many environmental characteristics that buildings are comprised of (Rousseau and Wasley 1999). Comfort encompasses much more than just a physically well-arranged environment, it must also provide stimulation and interest that are intended for user satisfaction and well-being. Good design recognizes that health is much more than the absence of disease as it is also a sense of well-being supported by intangible aspects of architectural spaces. In other words, healthy buildings are not just for sick people, they are also vital to user health.

Architectural spaces contribute to human experience. It is therefore important that spaces be in harmony with space users so that they may experience good moods as well as feelings of comfort and satisfaction. When not in harmony with the environment humans can experience resistance or stress which can cause eventual health problems (Fischer 1983).

Research has revealed aspects of architectural spaces and their influence on the well-being of humans (Vischer 1985, 1989, 2005). For example, characteristics such as natural light play an imperative role in human well-being therefore the placement of windows in a room is an important consideration. The shape of a building also shapes its interior which in turn has a critical effect on peoples' comfort and well being (Alexander, Ishikawa et al. 1977).

Rousseau and Wasley (1999) state that:

> Concerns over healthy housing are well founded. Our lives today are more complex, stressful and difficult than ever before. Physical and emotional trauma and anxiety are daily conditions for many. Not one of us is immune to family problems, financial worries, safety concerns, and fears about the future of society and the environment. Another layer of stress from toxic or allergenic environmental exposures and poor living and working conditions can overload the immune system, leading to environmental sensitivity which can, in the long term, have serious consequences for sufferers and everyone close to them. (p. 3)

Feelings of satisfaction and well-being within architectural spaces have grown to be important issues for space planners. As designed environments progress to become more complex, new areas of specialization will continue to develop. Health, safety and welfare of the public are of prime importance in the designing of architectural spaces (Guérin and Martin 2004).

Therefore concepts of Human Behaviour / Built Environment Relationships, in relation to mood, well-being, comfort and satisfaction are used as a base for the theoretical framework for the present study of how intangible aspects of architectural spaces influence the well being of humans. Using the Hierarchy of Needs (Maslow, in Norwood 2006), as shown in Figure 1-3, it can be interpreted that the more we escalate on the pyramid and go beyond basic physical requirements in our environments, the closer we get to self-realization and to feelings of well-being in the spaces within which we live. This is also closely related to The Habitability Pyramid (Preiser and Taylor 1983, Vischer 2005), shown

in Figure 1-4, that also goes beyond basic physical, functional and psychological comfort levels to attain occupant satisfaction and well-being (Vischer 1985, 1989). Furthermore, Alexander's (1979) 'solidity of subjective human feelings' as a scientific approach holds value as it investigates first person subjective experiential material that will be essential to finding out how intangible aspects of architectural spaces influence the well-being of humans.

In chapter two the research context for this study is explained as well as the two methodological approaches that will be used to investigate first person subjective experiential material.

CHAPTER 2:

METHODOLOGICAL APPROACH

RESEARCH CONTEXT

Designers involved in contemporary architecture are often engaged with poetics and discourse. Intellectual and conceptual dimensions of design are frequently over-emphasised and this contributes to the disappearance of the sensual essence of architecture (Pallasmaa 2005). It is architecture's mission to stand as a powerful reminder of our full potential since where we are heavily influences who we can be (de Botton 2006). In order to achieve this, fundamental theory and practical research methods are necessary to access human experiential responses to space.

As of quite recently, the relationship between design and human behaviour was not questioned as it is in today's world of aging population. Today, humans, their behaviours, and how their physical, social, functional and psychological needs are met through the interior environment are a growing concern. Specialized areas of study and practice have opened the way for more focus on the health, safety and welfare of the public (Guérin and Martin 2004). With this in mind, it is of crucial importance to continue research on this multi-faceted subject, which can be applied to a wide and complex variety of different architectural spaces. The idea is to find solutions that will enhance the quality of life and culture of the occupants for the sake of their physical and mental well-being. The purpose of this research is therefore to explore the complex relationship between interior environments and human behaviour so as to better understand human needs. To do this, the following research questions are explored:

1. What are the intangible aspects of architectural spaces that enhance the well-being of humans?
2. How can these enhance a person's mood, satisfaction and long term well-being?

Based on the Model of Human Experiential Response to Space as shown in Figure 3-1 and on Vischer's (2005) Environmental Comfort Model of User-Space Interaction: the Comfort-Productivity Continuum as shown in Figure 4-1, two hypotheses are developed and form the core of this research.

Hypothesis #1

People's moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit.

Hypothesis #2

Setting the right mood for people while conveying a positive atmosphere will generate feelings of well-being and therefore less stress and adaptation to spaces within which they live.

In designing architectural spaces research based on both qualitative and quantitative research approaches may be useful in order to reveal subjective experiential material that is necessary to enable solutions that respond to human welfare. Described in the following pages, both of these methods are used for this research in order to find out what it is about architectural spaces that influence human well-being. The goal is to be able to address the questions and hypotheses of this research so that the outcomes may be made available to professionals who design spaces for human welfare.

To begin with, a qualitative and a quantitative approach is used to find out how space users feel the general atmosphere of a space, composed of multiple architectural characteristics, influences their mood, satisfaction and overall well-being. Qualitative research, through narrative inquiry, is used because it aims at capturing experiential material which can complement quantitative methods. Narratives represent subjective reality and they are shared by both the researcher, who can foresee design solutions as viewed from multiple perspectives and the authors for which spaces are to be designed. Then neuroscientific research in architecture is explored. This quantitative research method complements and enriches the results of the qualitative method.

Both methodological approaches complement each other in being able to offer far reaching possibilities for designers who aim at accessing human experiential material before designing spaces that are geared toward human well-being. Below, a summary is given of narrative inquiry and neuroscience research as approaches to investigate the not so obvious intangibles that affect how individuals feel environmental characteristics in a space influence their well-being.

QUALITATIVE RESEARCH APPROACH

In this research, the qualitative methodological approach aims at capturing subjective experiential material that is essential to find out how individuals feel environmental characteristics affect their mood, stress levels and satisfaction in the spaces within which they live, work or play.

More specifically, narrative inquiry is used for this study because it is an interdisciplinary research method that allows for people's realities to be constructed through the narration of their stories. Genuine information, derived directly from the narrator's story, can be authenticated where both the author and the narrator assure and validate that what has been written is well interpreted as the 'truth' of what has been said (Clandinin and Connelly 2000).

Following is an overview of the qualitative approach using narrative inquiry and its relevance to interior design. The context for narrative inquiry is described as well as examples of how narrative inquiry, as a method of qualitative research, has been used to date.

Narrative Inquiry

Methods of narrative inquiry involve different steps including integration, finding informers, creating a discussion canvas, collecting data, transcribing data, as well as analysing and interpreting data (Mucchielli 2004). Each step is briefly described below.

Integration: The first step to narrative approach is for the author to get acquainted with the narrators before starting to inquire about their personal life. A way to do this is to observe and then take part in some of the activities that are taking place in order to get accepted. The idea is to remember what has been observed without asking questions. This aids the researcher in being informed on the subject matter, in questioning himself and in writing down the information that he gathers by observing. This is a preparation step whereby clarifying the subject to be studied can aid in defining the research problem (Mucchielli 2004).

Finding informers: During the integration phase, the researcher starts to select questions that relate to the research problem, questions that he will ask the narrators who will recount their life stories. To avoid choosing a person that has no interest in the study, during this phase, the researcher tries to recognize which persons may be better qualified to answer the questions that he will be inquiring about and which person he can establish personal contacts with for this part of the process (Mucchielli 2004).

Discussion canvas: Preparing a written discussion canvas before beginning an interview may help the researcher position themes as he listens to the recordings of the narrator's story. Though themes from the narrated story may not always fit into the original framework, space should be allocated to allow new themes to be recorded as they occur. This pre-set canvas can help solidify initial themes of inquiry and will allow the placement of original themes that may change during narration (Mucchielli 2004).

Data collection: Once informers have been selected, data collection may begin where the researcher must refrain from directing the narrator. The objective is to allow time for the narrator to have confidence in the narrator. If the narrator shifts off onto a different subject, the researcher may discretely ask to repeat a word or a theme that relates to the object of study. From one narration to another the researcher can eventually invite the narrator to delve into specific subject matter that he feels still remains unclear. This is how narratives can be useful in providing the necessary information that is required for the research. As recordings are being reviewed, if there is subject matter that needs to be

clarified, or issues that have not been covered, in the next session of narration, the researcher can address the issues that have been overlooked. In a spiralling effect, this iterative approach allows both the researcher and narrator to bring precision to the subject of study since they will have the feeling that they are both on the same level of knowledge and comprehension (Mucchielli 2004).

Transcription of data*:* Transcribing of data can be done at several intervals. Transcripts can be read, and read over again, as the first transcriptions may not necessarily make much sense. Information that has no value to the study can be discarded and texts harmonized to keep a comprehensive continuity. The researcher must render the texts legible while using good sense and intellectual honesty (Mucchielli 2004).

The next phase is to transcribe all data and to include graphic documents and pictures that may help the comprehension of the texts. These are then used to analyse and interpret the information. The researcher must establish a coherent text by grouping information into categories and he must make sure that there is a visible distinction between what has been narrated and what he, as the researcher, adds (titles, sub-titles, chapters, transitions, annotations, comments). Researcher comments must not be included in the text (Mucchielli 2004).

Analysis and interpretation: The researcher then analyses and interprets the information from the narratives and writes what the narrator has expressed in the most authentic words (Mucchielli 2004).

The Labovian Framework

Constructing a well-designed, well-written case study is no easy task and paradoxically the ‘’*softer*’’ a research technique is perceived to be the greater the difficulty may be to execute it well (Yin 1989). Therefore, personal narratives depend on certain structures to hold them together. One structure is the Labovian framework for examining oral, first person description of past events (Labov and Waletzky 1967; Labov 1972). This largely cited approach was originally developed on adolescent and adult populations

(Langelier 1989; Riessman 1993) and certain applications have studied the narratives of children (McCabe and Peterson 1991).

Labovian framework: For Labov, a well-constructed narrative contains six steps: 1-an *abstract* which summarizes the plot line of the narrative; 2-the *orientation* which introduces the characters, place, time and context of the narrative; 3-a *complicating* action which shows the sequence of events within the narrative, often delineating tension points and key issues that do not lend themselves to single interpretations or right answers; 4-an *evaluation* which moves the narrative from description to analysis. A point of contention in qualitative research occurs over the issue of analysis, and discussion of data (Wolcott 1990). This also applies to narrative inquiry where theorists are divided on how best to represent the relationship between the informants and the researcher who acts as interpreter and case writer (Langelier 1989; Riessman 1993). Prior to data collection, categories for content analysis can originate from literature and eventually be adjusted as the narrative evolves; 5-a *resolution* which examines the outcome of the narrative and; 6-a *coda* that brings the narrative back into the present by concluding or unveiling a lesson.

These explanations indicate the power of narrative inquiry where the iterative approach helps shape narrator stories. The subjective experiential material obtained through this approach can be useful to uncover data that is most often implicit and cannot otherwise be captured through observation and questionnaires.

In the next section, we discuss the relevance of narrative inquiry to interior design research as it embraces the subjective expression of the individual for whom designers design spaces.

Relevance to Interior Design

In scientific fields, where research is a common aspect to discovering new issues, practice also advances while benefiting from these findings. Therefore, research in practice-based fields such as those related to environmental planning (ex: architecture, interior

design, and industrial design) could benefit space planners by providing them with research findings that help support users' needs, satisfaction and well-being.

Narrative inquiry, which addresses implicit human experiential material, may hold extensive value for interior design research. For example, a paying client may often opt for open space planning to save on square footage costs while he himself may enjoy the comfort of an elegant, closed off, large corner office which has windows that overlook the best views of the city. Given this reality, it may be helpful to have space users speak for themselves when it comes to expressing true feelings about what is 'right' for them within an interior space.

Strange as it may seem, most people would rather dream of a closed office than an open office… or, would they? Humm!!! What if everyone's needs were different? What if there are similarities in peoples' needs? What are those similarities? Given the choice, people do arrange their personal homes to suit their needs and tastes which differ from the ones of their neighbours. In doing so, they benefit from the comfort and satisfaction that these homes provide them. Of course, they've arranged their living environment to the way that best suits their needs and desires. Why then should we suppose that a group of individuals, let's say in an office setting, would be expected to be efficient in their work environment if they haven't been consulted or given the choice as to what type of environment they would most comfortably be able to work in? If a work environment suits the needs of space users, they may be able to be more comfortable and therefore more productive while at work (Fischer 1983, Fischer and Vischer 1998, Vischer 2005, Zeisel 2005).

Space users cannot all be interviewed during the pre-design phases due to time and budget constraints. Trying to remedy everyone's complaints and to satisfy everyone's needs could be costly, time consuming and an almost impossible task to achieve. Furthermore, employers may be concerned about their probable inability to fulfill every employee's demands. Therefore, using narrative inquiry to consider the voices of persons who are utilising the spaces that are being designed for them may not only respond to their needs

but may also respond to the needs of other space users in the same architectural setting. Doing research to access opinions on how humans feel environmental characteristics influence them (Alexander, Silverstein et al. 1975, Alexander, Ishikawa et al. 1977, Alexander 1979) has become an important issue which must be addressed.

This research paper specifically addresses residential and work environments where space users can express their feelings as to how environmental characteristics affect their mood and satisfaction. These represent good choices for the hypotheses we want to prove since participants will be in direct contact with the researcher and will be able to convey what it is about the environment that makes them feel the way they do.

Examples of Narrative Inquiry

The narrative approach used for this study begins with a self-inquiry (Houle 1997) about what aspects of architectural spaces influence the well-being of humans. This was a legitimate first stage of the research in order to set an initial framework that could be adjusted or modified before beginning inquiries with participants. Results from this self-inquiry showed that it is not necessarily individual aspects in particular that make people feel '*right*', but a whole array of environmental characteristics that form a whole. Results were therefore used to structure subsequent data collection for other participants.

Since each person perceives their well-being differently from one space to another, the difficulty laid in '*how*' one could access individuals to find out what makes them feel the way they do in the spaces within which they occupy. It was therefore imperative to set an initial framework to access the researcher's own human experiential responses to space in order to then survey other participants who would generate additional knowledge on how architectural spaces influence human well-being.

Personal narratives are a way of expressing the voice of the ones that are being narrated (Houle 1997). The information derived from these can be used to generate knowledge on how architectural spaces influence human well-being. This can be done by

combining research and practice where design professionals work in collaboration with researchers. By continually doing research to find out about space users' needs, corroboration of data may unveil that certain environmental characteristics are important and similar for the well-being of all humans.

Design educators can also introduce alternative methods of collecting data in teaching programming to identify information that is most relevant to an organization's success. Students can be made aware that methods of data collection, which exists in other fields, can be adapted for design and that qualitative methods hold particular relevance to design. Narrative research, for instance, emphasizes human variables and seeks to find patterns in their complexity without being prescriptive or formulaic. In addition, it is based on listening to clients without identifying solutions too early in a project. For students and practitioners alike, this can be important in terms of understanding that key issues often have to be discovered and are not always apparent, even to the client. Listening to space user narratives to find out how architectural spaces affect their moods and feelings provides tremendous information for the design process. Narrative research expands the type of knowledge used to inform design.

An increasing number of practice-based disciplines are embracing narrative inquiry as a powerful means of teaching the more intangible, human-centred issues of professional practice (Danko, Meneely et al. 2006). Listening to users' stories as to how they 'feel' within a space provides a more holistic approach to accessing subjective information that can be used to address personal needs (Alexander, Silverstein et al. 1975, Alexander, Ishikawa et al. 1977, Alexander 1979). This humanized design process nurtures empathy and enhances narrator-researcher relationships, which foster a better understanding of the stories that are being recounted. Each story is authentic and rooted in the here-and-now of the most urgent issues facing business and design practice today (Danko, Portillo et al. 1999). With post-modern critiques of representation and authority, many scholars are tempted to abandon the task of verification, especially when they construe the narrator as a subject worthy of their support (Stoll 1999). Researchers may tend to ignore, grow

impatient with, or get thrown off track by interviewees' stories that seem to go out of bounds to what they are trying to research– and later realize their mistake (Mishler 1986; Anderson and Jack 1991; Narayan and George 2002; Riessman 2002). The use of narrative criteria in making design decisions depends on the designer's belief in an environment's ability to communicate meanings that are important for human understanding (Ganoe 1999). Information derived from stories people tell become the basis of empirical material that researchers need to understand how people create meaning out of events in their lives (Denzin and Lincoln 2005).

As a way of cultivating a more reflective practitioner and nurturing an intellectual and emotional development, personal narratives provide emotional development centered on issues of self-awareness and social-awareness (Danko 2003). They are useful tools that provide designers with insights as to how clients may '*feel*' environmental characteristics affect them while hearing their stories. Narratives bring to light past and present subjective experiences that can be shared and compared in order to predict design solutions that may foster user satisfaction and well-being. It is clear that the story format is powerful in communicating design messages (Danko and Portillo 2001). It also teaches significant lessons about the importance of interaction between personal and professional growth.

Narrative inquiry offers a structure for capturing cultural richness that augments scientific inquiry and helps our understanding of interior design processes and products. Recounted stories based on the captured voices of end-users, clients and designers reveal shared meanings and values (Portillo 2000) while engaging our attention and augmenting learning and recall. Narratives focus on subjective reality, they allow for design to be viewed from multiple lenses and they are based on the experiences shared by designers and space users. Interpreting architectural space as a narrative adds depth and breadth to the understanding of how the environment is psychologically inhabited by the individual (Ganoe 2000).

Narrative inquiry is relevant to interior design research as it embraces the subjective expression of the individual for whom professionals design spaces. Narrative inquiry

focuses on people, which are the primary assets of user-space relationships. Narratives offer new insights and additional information that are necessary to better comprehend people and their relationship to the environment. Following are two examples of how narrative inquiry has been used to date in the practice of interior design.

The first example demonstrates how the relationship between Eva Maddox Associates and Du Pont Antron evolved over nearly two decades and documented the dynamics of a creative process (Portillo and Dohr 2000). The second example illustrates how narrative research is utilized in situations when STUDIOS Architecture examines mental models of work environments held by clients and end-users (Budd 2000).

-Eva Maddox Associates (EMA) (Portillo and Dohr 2000)

In this example, aspects of creativity are viewed by interviewing a designer and a client group as they reflect on an award winning design project and their relationship of nearly two decades. The narrative is constructed from semi-structured interviews with key informants and an on-site project analysis. The case selection criteria includes 1-a professionally recognized design firm and project, 2-access to multiple sources of evidence, 3-authenticity in the reporting of events, and 4-access to the project site. The interview data were transcribed and the narrative structure was constructed and analysed.

The purpose of the study was to examine creativity through a narrative documenting designer and client accounts of an award-winning design project and a twenty-year collaborative process. The objectives of the study were to articulate a multi-vocal narrative of a design project, independently recounted by designer and client/end users, communicate a non-didactic narrative of design as an important strategy for the design client and create a well-structured, theory-based narrative of creativity in practice

Findings showed that traditional design services developed into a pioneering of innovative design initiatives that advanced corporate strategy. The case revealed creativity as developmental, complex, strategic, and enhancing the identity of the client's product and services. Thus, this narrative approach to design research more fully captured the

complexity of a real-world creativity that previous methods helped establish. It also points toward a progressive model of interior design practice (Portillo and Dohr 2000).

The final result of the narrated story provided insights into the depth of creativity found in interior design practice, through the EMA story. This story was seen as the synthesis of person, process, product, and press. The designer in this narrative was seen as the person who personified the definition of creativity as combining unlike things into a new whole that has value and beauty.

This narrative expanded the firms understanding of creativity as a developmental phenomenon. It gave insight to the team approach within the creative process. Though at first sight it may have seemed that individuals in the team contributed their unique skill and expertise, the narrative found that the team shared common knowledge, experience and trust that contribute to an expansive problem-solving process that is also influenced by the environmental context.

The narrative documented the dynamics of a creative process for the two-decade relationship between EMA and Du Pont Antron. It revealed that achievements have been driven by creativity that was developmental, complex and strategic. The narrative also showed that EMA generated creative solutions that supported different levels of participation within the space and beyond the space. It was found that the description of the creative process achieved clarity in the telling by the voices in the ensemble. It was also found that the narrative gave insight into the team approach during the creative process.

In considering a new method to examine creativity in design practice, this narrative inquiry offers a model suited to the discipline. Furthermore, it shows that insight gathered from narratives can be useful to design students who are shaping their perceptions about creativity and must go beyond content-based knowledge and ameliorate their approach to creative problem solving.

-Studios Architecture (Budd 2000)

In this example, STUDIOS Architecture examines narrative research in practice where mental models of work environments held by clients and end-users are explored. Holistic content methodologies are used to capture narratives from a wide range of individuals in order to define the organization within a collective voice. Traditional content analysis is used to deconstruct and analyse narrative content. A predetermined research scope determines the initial parameters of analysis to be most meaningful to the client. Groupings of meanings are established to fit the project objectives while patterns are identified within the narratives to capture mental models of work environments.

STUDIOS Architecture is an architectural firm that bases its practice in design and business innovation. They approach the built environment as a partner with work processes, technology, human capital, culture and knowledge structures to achieve a desired outcome. Using segments of narrative content in their firm as well as narrative cases, the purpose of their study is to illustrate how design practice can use narrative research to realize client benefits.

Though quantifiable measures for research are valued by many organizations, these do not allow the exploration of the intangibles of the work environment. STUDIOS did not feel that these addressed the human aspects of organization such as culture, motivation, process change, or exchange of knowledge. Therefore they began to develop and adapt research methodologies to aid in analyzing the human component of organization in order to assess the importance of that data on a client's objectives. This rigour reflected a need for STUDIOS to realize profit while supplying a valuable product for clients. Their objective was to investigate the mental models of work environments that coexist with the physical design models the firm constructs.

STUDIOS felt that they needed better tools to identify business goals. Interior environments were being defined, sold and accepted by most design firms in ways that lacked depth and a true understanding of the organizations for which they were designed.

By using narratives to uncover mental models meant for STUDIOS to understand the greater context into which the physical environment was introduced.

Post-project interviews indicate that clients that had received these services felt STUDIOS' approach was extremely beneficial in early identification of potential problems and were critical in developing a tailored approach to their unique set of issues. These workplace analyses were accompanied by segments of narrative to illustrate specific points. This way, less time was spent debating whether or not an issue existed and more time was spent discussing why it existed.

Client reactions vary depending on what type of group delivers the new environment. When the group is managed with executive leadership and corporate strategy, the analyses are better comprehended and related to business issues. Clients acknowledge that the final outcome of narrative research performed by STUDIOS is unlikely to be achieved without a qualitative analysis of space users. Both STUDIOS and clients agree that the resulting environment could not be anticipated without a prior narrative exercise.

This example demonstrates that client narrations bring on rich information as to how people work and what assumptions guide their working behaviours. STUDIOS adapted their model of analysis for practice because it focuses on people and their mental models of work environment. This method was adapted to practice in order to complement methods that honour discreet units of measures such as real estate analysis and time-utilization studies that are not designed to explain the subjective experience. To add value to design projects, by utilising narrative inquiry, analysis is able to focus more on people who are the primary assets of most organizations.

These are two examples of how narrative inquiry has been used as a qualitative research method in the field of interior design. They have been illustrated to show that narrative inquiry can also be used as a qualitative research method for the present study in order to capture human experiential material to find out how intangible aspects of architectural spaces enhance human well-being. Qualitative research through narrative

inquiry allows an iterative approach whereby life stories give input into subjective reality that should be considered when designing spaces for user well-being.

QUANTITATIVE RESEARCH APPROACH

To further explore what it is about interior environments that enhances the well-being of humans a quantitative approach is also used in this research. To compliment the use of narrative, what follows is an empirical study measuring the effects on neuroscientific concepts of certain architectural features.

Advances in neuroscience are developing that advance research on human behavior related to the built environment. Furthermore, environment-behaviour research, which incorporates neurosciences, takes into account neuronal structure and activity of the brain. The challenge is to access experiential material that can be used to design environments by adding neuroscience perspectives and methods to existing environmental-behaviour frameworks.

Data acquired through a questionnaire survey designed to measure neuroscientific correlates of architectural features provides a scientific basis for advancing the nascent discipline of neuroscientific research in architecture. This approach is useful in that it captures how space users feel environmental characteristics influence their mood, ability to focus attention and stress levels in the spaces within which they work.

Following is an overview of the quantitative approach using neuroscientific research and how it was investigated through workshops and research projects. This is followed by an explanation of how this type of research helps us understand the effects of interior spaces on humans.

Neuroscientific Research in Architecture

Efforts to understand the relationship between the brain and the built environment has encouraged the collaboration of architects and scientists to study how the human brain perceives and responds to cues from architecture. The goal is to promote and advance

knowledge that links neuroscientific research to a growing understanding of human responses to the built environment.

As research between neuroscience and architecture aims at a greater understanding of architecture to enrich the human experience, those who design places for human use may consider working side by side with neuroscientists to find research-based knowledge that will allow them to predict consequences of design decisions and use these to support their design proposals.

Eberhard (2003), consultant and member of the American Institute of Architecture (AIA), has identified potential research bridges between the disciplines of neurology and architecture, including the built environment's effects on the healing of patients in health-care facilities, productivity in the work-place, enriching the learning experience in K-12 classrooms, and way-finding in complex buildings. Eberhard (2005) stipulates that:

> As we 'behave' in a new environment into which we have been born some of the connections between neuronal groups are strengthened and some are weakened. As a result, new combinations of groups taken from the primary repertoire are associated with signals from the outside world. These new formations create a set of 'secondary repertoires' consisting of functional groups likely to be used in response to our 'future behaviour'. (p. 23)

The way each and every one of us experiences architectural spaces affects how our body and brain engages into that space. As we constantly register environmental variables such as air temperatures, lighting, noise, odours, furniture and spatial comfort we build on our cognitive senses and develop our own perceptions and preferences (Eberhard 2005).

In the light of these theories, focus groups composed of architects, neuroscientists as well as participants from research and academic communities have explored the field of neuroscience and architecture and developed hypotheses in relation to brain mechanisms through which places affect cognition, learning, creativity, mood and productivity. In stress

research, scientists rely on cortisol and saliva tests to find out how participants react to environmental characteristics. Most design-based research opts for an empirical approach where space users provide feedback through questionnaires and interviews administered in direct contact with the researcher.

Other research in neuroscience and architecture focuses on aspects such as windows in hospital settings, light in teaching environments as well as color in office spaces. Although these focus on single aspects of interior environments, further research can aim at a more global approach where several elements of the environment are taken into account. Following are examples of workshops and Environment-Behaviour and Neurosciences (E/B/N) research projects that have been developed.

-Workshops and Research Projects

As the field of neuroscience and architecture is relatively new, there is a growing interest for architects and neuroscientists to get together in order to find out how the brain responds to architectural settings. The profession of architecture has become a partner in developing the application of the expanding body of knowledge that has evolved within the neuroscience community. Over the past few years The Academy of Neuroscience for Architecture (ANFA) has organized workshops on healthcare facilities, sacred places, and on K-6 classrooms. These workshops, which involved architects, neuroscientists and research assistants, can be useful for space planners who design spaces for human use. They have certainly been helpful in identifying areas of research such as sounds, light levels, spatial competence, colour, visual functions, wayfinding, privacy and calming environments and their impact on humans.

Hypotheses developed from these workshops and other research findings, brought about the following main question:

- What can architecture contribute to the human experience (Eberhard 2005)?

Being led by this major question, below are stated more specific ones that have arisen since (Eberhard 2005):

- What is going on in the brain when it responds to environmental factors? (Jarmusch 2003, p.2)
- Why do patients in a hospital respond better to certain colours? (Zeisel 2005, p.31)
- Why is the cognitive ability of children in a classroom impacted by background noise? (Zeisel 2005, p. 31)
- Why do Alzheimer's patients respond positively to sunlight? (Zeisel 2005. p.31)
- Are patients different than normal healthy individuals? (Edelstein 2004, p.17)
- Does the set point for the need for privacy change when people become ill? How and why? How do we respond as designers? (Edelstein 2004, p.17)
- Is there a range of stimuli that will provoke normative privacy responses in spite of the variability? (Edelstein 2004, p.17)

The hypotheses and questions were produced so that they could be used to guide further research development. They have stimulated researchers, architects and designers to pursue research that corresponds to humans and the built environment while considering the environments' influence on the brain.

For example, one of the research projects which has evolved to find bridges between neuroscience and architecture is at the Krasnow Institute of George Mason University. Here Meredith Banasiak, Assoc. AIA and research associate in the Washington office of ANFA, has been collecting data from interviews that involve staff composed of senior neuroscientists and their associates and technicians in regards to new laboratories that were added to their building in 2005.

The Need for Neuroscientific Research

There is a strong willingness for neuroscientists and architects to work together to improve architectural spaces by developing tools that will benefit the architectural design process that now relies more on intuition and 'soft' scientific information. These tools may

bring us answers concerning such aspects as the effects of the built environment on the healing of patients in health-care facilities, productivity in the work-place, enriching the learning experience in K-12 classrooms, and way-finding in complex buildings (Eberhard 2003).

Using research on neuroscientific correlates the research presented in this thesis explores eight brain-based neuro-environment factors (Zeisel 2006) in order to show that environmental characteristics can be designed to suit the needs of space users in order to heighten sense of satisfaction and well-being which, in addition, may also heighten task performance. Neuroscientific correlates reveal that the environment can affect human moods, ability to focus attention and stress levels.

Research to find out what intangible aspects of interior spaces enhance the well-being of humans may reveal basic necessities that are essential to all peoples, no matter what age, gender or culture. This is what this thesis addresses. First, self-inquiry is used to study environments where the researcher has lived, worked and attended school over a 45-year span. Results of how these environments have affected her mood, satisfaction and well-being are then used to build the narrative framework to interrogate three other participants where results are analysed for residential and work environments. In the second study a questionnaire is devised based on neuroscientific correlates of architectural space in order to collect data from space users on how aspects of their workspace affected certain neuroscientific behaviours.

SUMMARY

It is clear that the concern for interior spaces has evolved a new type of practice, which must assess the qualitative and quantitative needs of the user. The idea of health, safety, air quality, lighting, ergonomics, environmental sustainability, egress, fire safety, and accessibility are added responsibilities of interior designers (Guérin and Martin 2004, Johnson 2000). This knowledge will lead to substantial benefits for the users who will

benefit from interior environments created for the improvement of the quality of human experience.

Both quantitative and qualitative research approaches are used for this research and, although they differ in many ways, they also complement each other. The relationship between the choice of both narrative inquiry and neuroscientific correlates is that both deal with issues of how humans '*feel*' architectural environments impact their well-being. In both cases, the goal is to find out what it is about the environment that enhances a person's mood, satisfaction and long-term well-being so that spaces can be designed to convey a positive atmosphere thereby generating feelings of well-being and reducing stress (Vischer 2005).

A subjective, qualitative approach can unearth concepts through an inductive, iterative approach where the researcher builds abstractions, concepts, hypotheses, and theories from details (Merriam 1988). The researcher tends to become subjectively immersed in the subject matter as it evolves with time. This approach involves the analysis of data which can come from interviews, pictures or objects (Miles and Huberman 1984).

Using narrative inquiry to test hypotheses regarding intangible aspects of architectural spaces allows us to capture participants' voices concerning moods, satisfaction and well-being and how they are affected by elements of the space they occupy in ways that are neither direct nor always explicit. By having knowledge of what better suits individuals in a space, designers can use findings to design spaces that set the right mood, while conveying a positive atmosphere that will generate feelings of satisfaction and well-being.

As most research on user behaviour focuses on expressed and explicit behaviour, our goal in using the qualitative method of narrative inquiry is to delve deeper into the underpinnings of the human response to space, that is, what is implicit and not always expressed by users. Using narrative inquiry to test hypotheses regarding intangible aspects of architectural spaces aims at finding ways of accessing human experiential material that

can be used to generate additional knowledge on how environmental characteristics of architectural spaces influence human well-being.

Using narrative inquiry enables adjustments and the reformulation of research questions through a constant come and go between the object, the facts and the analysis of study. This type of participative research favours partnerships and contributes to local and scientific knowledge (Gendron 1998). As theory is elaborated progressively, the questions are refined and the proposals take shape while the data is analysed. In this research, the data not only derives from theoretical knowledge and people's narratives, but also from analysis of the collected data. As data collection and analysis progress, the object of study is refined and the questions become more and more precise. A narrative approach to design research more fully captures the complexity of real-world creativity and points toward a progressive model of interior design practice. It also offers advancement for interior design practice (Portillo and Dohr 2000).

On the other hand, quantitative research uses tools such as surveys and questionnaires that can be used to collect numerical data and provide measures of target concepts. In this case, the researcher tends to remain objectively separated from the subject matter (Miles and Huberman 1984). Quantitative research methods may help unveil concepts and build solid grounds on which to begin an interviewed interrogation.

Approaches can be combined (Patton 1990), but most important is to adhere to the methodology that best suits the subject being studied (Glesne and Peshkin 1992). Using both approaches this research addresses qualitative, subjective human matter as well as quantitative, objective matter. As quantitative research can help unearth data that is tangible and that can be fragmented, realities are multiple and holistic (Lincoln and Guba 1985) when dealing with issues that pertain to how humans feel in the environment within which they inhabit.

Both approaches used in this research can complement each other in several ways. The qualitative approach helps unveil patterns from data first derived from the authors self

inquiry, then from interviews with three other participants. As field study research can explore the processes and meanings of events (Marshall and Rossman 1980) the pluralism and complexity unveiled from new data accounted for a detailed descriptive report that assures authenticity of human subject matter. Then, a quantitative approach is used and is based on hypotheses and theories derived from the qualitative, narrative phase. In this phase, formal instruments are used and there is a sense of control during this deductive process.

The next three chapters of this thesis describe how both approaches have been used to identify intangible aspects of architectural spaces. These chapters are presented in the form of articles that will be submitted to journals. Chapter four, or Article 1, will be submitted to World Health Design. It uses narrative inquiry, as a qualitative approach, to identify intangible aspects of architectural spaces using three case studies. Chapter five, or Article 2, will be submitted to the Journal of Interior Design. Through a quantitative approach, it exemplifies how neuroscientific correlates of architectural spaces are used in a case study of space for work. This research method is also explored using three neuroscience concepts of mood, ability to focus attention and stress in order to measure how users respond to the built environment. Chapter six, or Article 3, will be submitted to the Journal of Environmental Psychology. It aims at defining the intangible aspects of architectural spaces by integrating qualitative and quantitative results.

The goal is to contribute to the interior design body of knowledge and to investigate how complementary research methods can be successfully applied to design. Data analysis is applied to test the hypothesis regarding intangible aspects of architectural spaces: first to test the hypothesis that people's moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit; then to test the hypothesis that setting the right mood for people while conveying a positive atmosphere generates feelings of well-being.

Using research methods to access human experiential responses in order to design spaces that are in tune with human needs could have far-reaching benefits. The challenge is

to create settings that suit human needs, that promote the fulfillment of human potential and that are relatively similar across people (Gifford 2002).

According to Rogers (2004):

> The interior environment is the environment that is easily changed to meet changing needs and interests and therefore mirrors rather accurately an individual, a people, or a culture. In its' finest expression, an interior environment becomes an art form, an art form subject to the requirements and vicissitudes of everyday life. It is a fugitive, changing and fragile environment as man, himself, is fugitive, changing and fragile. Its history, technology and social import are studied by educators, designers, social scientists and numerous other scholars. (p. V)

It is therefore important to embrace both research methods as a way to investigate the not so obvious intangibles that really affect how individuals feel in a space and then to further investigate data through quantitative methods.

CHAPTER 3:

OUTLINE OF THE STUDY

The origins of this work are my reflections on what it is about architectural spaces that influence human well-being. For example, when I found myself in crowded spaces or in spaces where there was a high noise level, I often felt fidgety, in a bad mood, or aggressive, while people around didn't seem to show any signs of unease. I wondered why noise and crowded spaces made me feel aggressive and why it was that I needed to pull away while others seemed to flourish in these spaces.

Although the notion of humans reacting to architectural spaces is well-established and documented in literature, architectural spaces are still designed as a one size fits all. By integrating research into design practice, knowledge about human experiential responses will continue to benefit space planners who design spaces for the well-being of space-users.

Architectural spaces are composed of physical characteristics and of the voids between them. These voids may be created to define traffic flows or may be created to embellish an object by providing sufficient space around it so that one can admire that object from a distance. For whatever purpose, voids contribute to the atmosphere created by a set of environmental characteristics.

INTANGIBLES AND SENSE OF PLACE

According to the Oxford dictionary, intangible signifies: unable to be touched; not having physical presence; difficult or impossible to define or understand; vague and abstract.[2] This relates to Merleau-Ponty's (1968) conception of the visible and the invisible where he stipulates that:

> The visible is a field, a relief, a topography unfolding by differentiation, by segregation, which holds together not by laws, but through the reflections, shadows, levels, and horizons between things (which are not things and are not nothings, but on the contrary mark out by themselves the fields of possible variation in the same

2 http://oxforddictionaries.com/definition/english/intangible?q=intangible. Retrieved September 1, 2013.

> thing and in the same world). Like the light, these levels and dimensions, this system of lines of force, are not what we see, they are that with which, according to which, we see. (p. li)

Merleau-Ponty's (1968) conception of the visible and the invisible applies to architectural spaces composed of environmental characteristics such as acoustics, sound proofing or artificial lighting. These characteristics may be considered intangible aspects of a space that compensate for the decrease in natural light or the abundance of noise. In the context of this study, intangibles are the sum of all the elements that contribute to an architectural space. Not one element alone, (or two, or three), but all environmental characteristics of architectural spaces, together and at once, influence and shape the lives of people.

Just like music where any tone in a series can function as an individual (Merleau-Ponty 1968), a table is a single physical object which has several purposes. Seen in a specific context, a table is no longer just a single, physical element of the space. It is a visible element, part of a whole environment, where the invisible which inhabits it, sustains it, and renders it visible, which allows us to experience that table through multiple lenses (Merleau-Ponty 1968). The table is an entity which contributes to the experience of that space, or to the *sense of that place.* Abbate (2005) refers to *sense of place* as being difficult to define because of its intangible nature of perception, memory, as well as associations and recollections all of which are perceived through our senses. He refers this to '*knowing it when you see it or sense it*'. Intangible aspects of architectural spaces relate to *sense of place* (Abbate 2005) since the sub-structures of both concepts relate to the invisible sub-structure of the visible, which is the key to the unconscious structure of consciousness (Merleau-Ponty 1968).

Mexican architect, Luis Barragan (1902-1988), devoted his whole life to finding an artistic expression that would embody the poetic richness of Mexico's past and current aesthetic trends. He combined the intangible essences of architecture (intimate spaces,

mystical light, sensuous materials, and arresting color) into an "emotional" architecture of poetry and mystery. [3] This research seeks a holistic approach, not widely acknowledged or discussed in the person-environment literature, which links intangibles to Abbate's (2005) theory of *sense of place*.

Intangibles and sense of place are closely related to behavioural concepts of place, personalization, territory, and wayfinding. Such concepts form the core of environment / behaviour theory and practice and play a significant role in shaping the brain. Zeisel (2006) describes each of these:

> A place is a space that holds meaning. Studies in neurosciences show that words and concepts that hold meaning are remembered and learned more profoundly than non-meaningful terms. This is likely to hold for meaningful spaces (places). (p. 356)
>
> Personalization is making a place our own in order to reflect our personalities, our past and our aspirations. Because memories of our past define ourselves, personalized environments reinforce a sense of who we are and provide us with a sense of self. (p. 357)
>
> Recognizing different types of territory, a skill closely related to place recognition, is essential to the survival of all species. Neuroscience studies can aid in defining territorial markers that work best for people of different cultures and subcultures. (p. 358)
>
> Wayfinding describes the mental and physical activities associated with finding our way which helps us explore new territories and negotiate new and urgent situations. Further understanding of spatial abilities will help designers more effectively plan environments for wayfinding. (p. 359)

[3] http: //www.thefreelibrary.com/Architect+of+the+intangible.-a011487503. Retrieved September 1, 2013.

The following paragraphs explain how these concepts have been addressed in the methodological approach used for this study, whose objective is to develop a better understanding of how the intangibles of a place affect users.

GENERAL METHODOLOGICAL APPROACH

The decision to combine subjective and objective approaches to measurement is based on design experience and related to research in human behaviour / person environment. Both approaches are also linked to Abbate's (2005) theory of *sense of place* because they refer to the fundamental stages of engagement or movement (orientation, threshold, arrival, wayfinding, circulation and departure) that constitute the experience of a place. As mentioned earlier, if participants feel comfortable within an environment because they feel well oriented and feel free to circulate as they wish, this may give them a sense of safety and they may want to prolong their stay or engagement in that environment.

One way to find out how space-users feel about the environment is to ask them (Zeisel 2006), therefore narratives were used to flesh out qualitative, subjective, intimate thoughts about how space-users feel about architectural spaces. Subsequently an objective test was used to derive scientific data on users' feelings (Alexander 1975, 1977, 1979). Capturing human experiential material is innovative in the field of environment-behaviour studies. Furthermore, Zeisel's (2006) brain design principles, which will be explained later in this chapter and in chapter 5, permitted intangibles to be viewed through a different lens and helped to ground the study into the framework of neuroscience and architecture.

An initial self-inquiry was used to understand my own events, thoughts and actions over time and permitted me to organize them into a meaningful whole. The narrations of others collected later provided the opportunity to do that, and also helped to connect all the data and to see the consequences of events and actions over time (Bruner 1986, Denzin and Lincoln 2005, Gubrium & Holstein 1997, Hinchman & Hinchman 2001, Laslett 1999, Polkinghorne 1995).

In order to delve further into the realm of intangibles and to measure interior design effects on space-users, neuro-environment assessments were then used to provide knowledge on how architectural spaces influence brain behaviour. Research in neuroscience and architecture aims at a greater understanding of architecture to enrich human experience and provides knowledge which allows designers to predict consequences of design decisions to support design proposals (Eberhard 2005).

At any time and place architectural spaces shape the range of possibilities for self and reality constructs, therefore narrating significant life events can contribute to facilitating change that can be positive for space users (Denzin and Lincoln, 2005). Since the goal is to explore how research can advance design, the pertinence of the methodological approaches chosen for this research is that they focus on the relationship between individuals' life stories and the quality of their lives in relation to the built environment (Denzin and Lincoln, 2005). Immersing scientific research with design practice produces new concepts and analyses that can enrich design practice (Denzin and Lincoln, 2005).

Though narrative inquiry captured human experiential material, time constraints reduced the number of participants and therefore the quantity of data collected. The researcher commuted to different cities to conduct the narrations in each person's home or office space (which seemed to be the most appropriate place to conduct interviews) and sat with each narrator for the duration of each interview. The one-on-one interviews may have caused too much comfort, discomfort or holding back on the part of the narrators, therefore stories that did not correlate with the area of study were eliminated. Hence, only four of the six narrated stories were used because they adequately addressed material that pertained to the study. On the other hand, neuroscientific research captured answers to how architectural space shapes the brain, but responses to the research question were limited by the neuroscientific concepts of mood, ability to focus attention and stress. Another limitation is that the nascent discipline of neuroarchitecture (neuroscience and architecture) is relatively new, scientific frameworks are relatively few, and other principles in addition to Zeisel's

are likely to exist. The way both research methods were used for this study is briefly described below.

Self-Inquiry

What emerged from my initial inquiries was that several environmental characteristics of architectural spaces (the whole atmosphere composed of colours, furniture arrangements, ceiling heights, views to the outdoors, nature, etc…) affect space-users' well-being. The difficulty lay into '*how*' one could access other people to find out what makes them feel the way they do in the spaces within which they live, work and sleep.

The study continued with recording my personal experiences and feelings that I recalled about interior atmospheres and moods in spaces where I had either worked in or lived in within the last 45 years. Beside each statement of the narration that was produced, I placed key words that best represented what I had just written regarding atmospheres and moods. The resulting 43 keywords were used as categories that were put into a table format to see how many times each category came up. The goal was to organise the data into useful or relevant categories for analysis and to refine the research instrument. Table 3-1, Physical, Functional, Social and Psychological Aspects of Architectural Spaces, depicts the resulting 43 categories and how they are subdivided into '*physical*', '*functional*', '*social*' and '*psychological*' aspects of architectural spaces. Numbers in parentheses indicate the number of times different elements of the narration were placed into each category.

These categories are closely linked to Vischer's (2005) model shown in Figure 1-2, How Environmental Comfort Works, where physical, functional and psychological comfort are combined to create a positive effect on morale and performance, and a functionally comfortable workspace can be used as a tool for work. A more detailed explanation of how this was done is found in Chapter 4. The objective of this stage of work was to first understand what it was about architectural spaces that affected me and to build a framework from which to investigate other space-users.

PHYSICAL, FUNCTIONAL, SOCIAL AND PSYCHOLOGICAL ASPECTS OF ARCHITECTURAL SPACES			
Physical Aspects	**Functional Aspects**	**Social Aspects**	**Psychological Aspects**
Accessories (1)	Adapting (16)	Community (3)	Appropriation (8)
Air quality (8)	Ergonomics (2)	Crowding (22)	Assurance (1)
Air temperature (7)	Flexibility (4)	Friendships (20)	Cognition (1)
Environmental factors (7)	Views (21)	Privacy (7)	Colour (21)
Furniture arrangement (15)		Relationships (2)	Comfort (3)
Geographic situation (3)		Social aspects (11)	Control (7)
Light (29) (artificial and daylight)		Territoriality (13)	Feelings (77)
Materials (38)			Memories (3)
Nature (38)			Noise (15)
Setting (46) (architectural, industrial, urban)			Odours (5)
Space characteristics (41)			Ownership (4)
Style (3)			Pets (6)
Transportation (3)			Perception (8)
Windows (6)			Relocation (2)
			Rooms with a story to tell (3)
			Satisfaction (9)
			Security (25)
			Stress (2)
14 categories (245)	4 categories (43)	7 categories (78)	18 categories (200)
Total: 43 categories (566)			

Table 3-1 Physical, Functional, Social and Psychological Aspects of Architectural Spaces

The Model of Human Experiential Responses to Space

The Model of Experiential Responses to Space, as shown in Figure 3-1, illustrates that architectural spaces are composed of several environmental characteristics (derived from the 43 categories found in the self-inquiry) that, together, generate atmospheres that are intangible. The resulting atmospheres generated from environmental characteristics affect user moods and shape human experiential responses. These responses can then be expressed as feelings such as satisfaction and well-being in a good environment or as

feelings of discomfort which can lead to stress in a bad environment (Vischer 2005). If the space-user can adapt to the space, this reduces stress. The harder it is for the space-user to adapt or the less successfully the space-user adapts, the more stress will result.

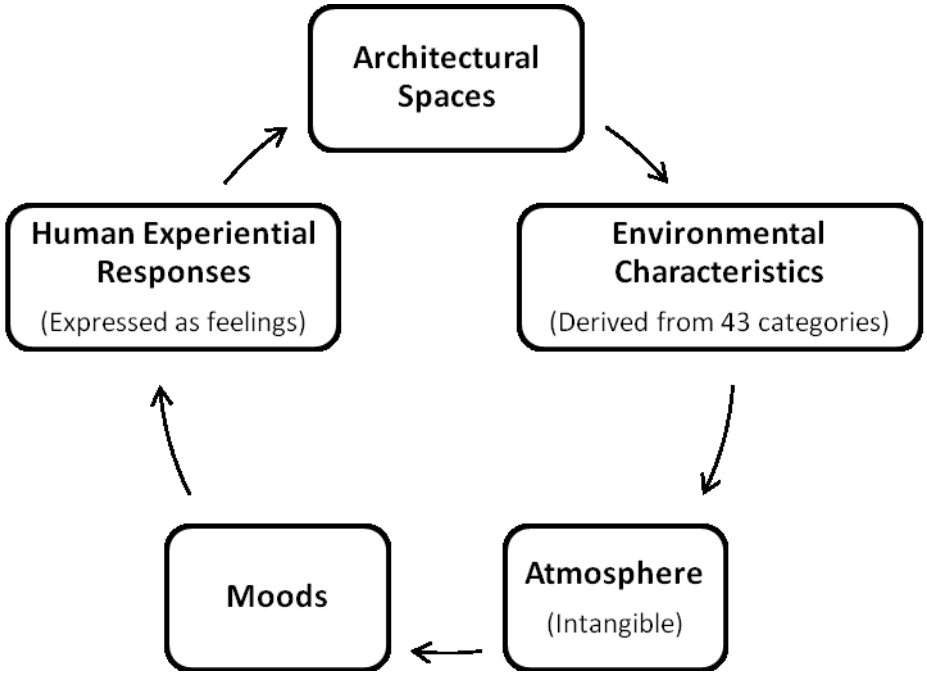

Figure 3-1 Model of Human Experiential Responses to Space

This model was created by the author to gain a better understanding of the links between human behaviour and the built environment. It served to show that every single environmental characteristic of architectural spaces, when combined together, affect users' moods. The arrows connecting each box show how environmental characteristics of a given space generate an atmosphere, which shapes moods that can be expressed as feelings.

Applying this model to the data from which the 43 environmental characteristics produced from the self-inquiry were derived was useful in my problem analysis because it helped to develop a testable hypothesis regarding how users experience and are affected by intangibles. In the model,

Architectural Spaces are planned, designed and constructed structures designed to meet societal needs so as to protect humans from exterior conditions. Architecture is the art of enclosing space where basic constituents are floors, a roof, walls and a fireplace (Malnar and Vodvarka 1992). Spaces, or shelters, are designed for human well-being and are utilized for living or working. No dwelling, building, or city is planned to be empty (Bechtel, in Malnar and Vodvarka 1992) and a basic architectural space represents a place to meet physiological needs for warmth, food and shelter (Maslow 1943). Therefore, human behaviour is enclosed by architecture and it is with the intertwining of several environmental characteristics (i.e.: physical, functional, social and psychological aspects) that these structural shells are composed of, that the architectural spaces become whole and intended for human use (Bechtel, in Malnar and Vodvarka 1992).

Environmental Characteristics, are derived from the 43 categories initiated from the self-inquiry. These encompass physical, functional, social and psychological aspects of architectural spaces. *Physical* aspects include tools to play, work, eat and sleep. *Functional* aspects include comfort characteristics such as adapting, ergonomics, flexibility, and views. *Social* aspects refer to the sense of oneself or of others. And, *psychological* aspects refer to how we perceive the environment. Grouping these four aspects together, as representative of the wholeness of space which affects space-users, defines the holistic way in which to approach the study.

Atmosphere is naturally created when all environmental characteristics put together form a whole affecting a space user's senses. This whole, or atmosphere, or ambiance, is the *intangible* aspect which is hard to describe. One can *feel* the atmosphere but cannot *touch* it. Feeling is also experienced through other senses such as seeing, hearing and smelling. Though the atmosphere of a space is composed of multiple physical elements, it remains in the subjective realm of intangibles. The combined effect of environmental characteristics felt by space users can result as feelings of satisfaction and well-being or as a feeling of stress and fatigue which can eventually lead to sickness.

Mood is the sum of effects caused by the added experiences of all senses. Mood is individual, it is relative, but can be shared. Mood is time, situation and culture dependent. In the context of this study, mood is the state of mind generated while experiencing the intangible atmosphere of an architectural space. It is the consequence of how one feels from being exposed to the atmosphere created by the multiple environmental characteristics of architectural spaces. When environmental characteristics are suited to space-users' needs and provide satisfaction, the more likely users are to be in a good mood and more efficient at performing tasks. Inversely, when environmental characteristics do not respond to space-users' needs this requires constant adaptation, and will likely result in bad mood and stress.

Vischer's (2005) Environmental Comfort Model of User-Space Interaction, developed from studies of workers in offices, shown in Figure 3-2, shows the comfort-productivity continuum illustrating that a *good environment* provides *energy* for space-users. In order to move on to the second stage of this research, the hypothesis that '*energy in*' will result in a *good mood* caused by *focus of attention* (being able to focus on tasks in a good environment where no adaptation, or little adaptation is required by the space-user) was added to the top right hand-side of the model. A good mood goes hand in hand with positive work performance. Where a *bad environment* signifies a *loss of energy* on the part of the employee, added to the top left hand-side of the model is the hypothesis that '*energy out*' will result in a *bad mood* caused by *stress* that inevitably goes hand in hand with negative work performance.

From this model it was hypothesized that setting the right mood for people while conveying a positive atmosphere (good environment / energy-in) will generate feelings of well-being and therefore less stress and adaptation (bad environment / energy-out) to spaces within which they live. This is directly linked to the Model of Human Experiential Responses to Space, as shown in Figure 3-1, whereby atmospheres generated from environmental characteristics affect user moods and shape human experiential responses which can be expressed as feelings such as satisfaction and well-being in a good environment or as feelings of discomfort which can lead to stress in a bad environment.

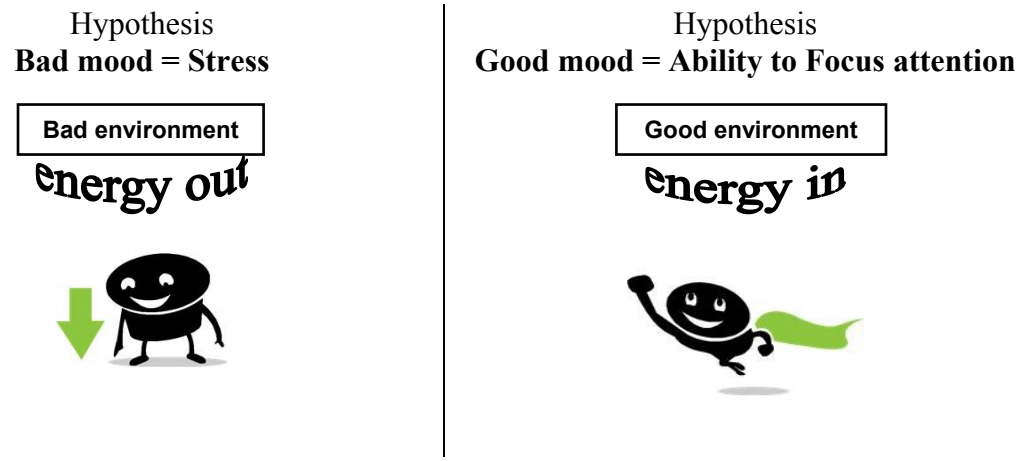

Figure 3-2 Environmental Comfort Model of User-Space Interaction: the comfort-productivity continuum (Vischer 2005)

Human experiential responses to space can be expressed as feelings of comfort and satisfaction or as feelings of stress and discontent. Architecture contributes to human experience and the more space users can be in harmony with the environment that surrounds them, the more they will experience good mood, and experience feelings of comfort and satisfaction. When not in tune with the environment, humans can experience a sort of resistance, or stress, and these resistances are experienced individually, at different levels, and can cause eventual health problems (Fischer 1983).

As seen in chapter one, both the Hierarchy of Needs pyramid (Maslow, in Norwood 2006) shown in Figure 1-3 and The Habitability Pyramid (Preiser and Taylor 1983, Vischer 2005) shown in Figure 1-4 are useful tools in understanding how humans can feel a level of satisfaction and well-being in the environments within which they live and work. Human experiential responses to space are not always easy to access for space planners when they design spaces or for researchers when they collect data from human subjects. Furthermore, space-users do not always have the ability to make direct links between what they feel and the spaces they inhabit. For example, natural light is essential and the placement of windows on two walls for every room is an important consideration; the shape of a building shapes its interior and this in turn has a critical effect on people's comfort and well-being; (Alexander, Ishikawa et al. 1977). As pointed out in chapters one and two, research has

revealed aspects of architectural spaces and their influence on human well-being. For example, Abbate's (2005) Key Attributes of Successful Places, as shown in Table 1-2, identifies specific types of intangibles that can be assessed through key attributes to successful places and that can also be accessed through narrative inquiry and neuroscientific research.

The Model of Human Experiential Responses to Space is not a global model of human environment relations, but rather a testable model of environmental intangibles. The model presents a dynamic process and demonstrates that multiple aspects of interior spaces have shaped, and will continue to shape, space users' reactions, which in turn affect people's long-term well-being. From this model it was hypothesized that peoples' moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit. This research aims at developing tools to access human experiential material that is not always explicit in order to design spaces that better respond to users' intangible experiences.

TWO RESEARCH METHODS

In order to test the Model of Experiential Responses to Space, a qualitative research method using narrative inquiry was used in combination with a quantitative research method based on survey data.

Qualitative research method: In the first phase of work self-inquiry was used to gather qualitative data to better understand implicit human experience in architectural spaces. In the second phase of work the 43 environmental characteristics of architectural spaces found to influence human well-being were used to analyse the content of narratives of three other participants. Abbate's (2005) theory of *sense of place* focuses on the intangible nature of perception, memory and associations, which are perceived through our senses, and which can be accessed by listening to and analyzing a space user's stories about that place.

One-on-one interviews were conducted with each participant (one residential narrator and two office space narrators) in order to record their narratives about how they

felt environmental characteristics of architectural spaces they had lived or worked in had affected them over the years. The intention was to use the same method that was applied during self-inquiry to guide the interviews and to analyse the other narratives.

Beside each statement of the narrations that were produced, key-words were placed to best represent what had been written regarding atmospheres and moods. The resulting 48 keywords were used as categories of environmental characteristics that were put into a table format to see how many times each category came up. The goal was to gather interesting analytic groups and to refine the research instrument. Table 3-2, Environmental Characteristics of Architectural Spaces, illustrates the resulting categories whereby five additional environmental characteristics were added from the initial 43 found through the self-inquiry. These were budget, preference, efficiency, age, and feelings of belonging and are found at the end of the table, numbered from 44 to 48. Categories were placed in alphabetical order to facilitate the constant cross-referencing of the four sets of data during data analysis.

The columns to the right of the categories represent data from the four narrators: *SI* represents the initial self inquiry, the *R* represents the residential narrator, the *1* represents the first office space narrator and the *2* represents the second office space narrator. Numbers in these columns and to the right of each category indicate the frequency that elements of the narrations were placed in each category.

Results of data analysis were interpreted, and a comparative analysis was performed. Results show that similar environmental characteristics suit the needs of space users in order to heighten sense of satisfaction and well-being for both residential and office space users. A discussion is built around the Model of Human Experiential Responses to Space and its purpose as a tool to unearth environmental characteristics that enhance well-being.

Narrative data analysis derived from the four narratives, as well as Alexander's (1975, 1977, 1979) approach to space-user *feelings* as a way to access human experiential material helped to solidify the precincts for the theoretical Model of Human Experiential

Responses to Space which explains key relationships between space-users and environmental intangibles.

ENVIRONMENTAL CHARACTERISTICS OF ARCHITECTURAL SPACES

COMPARING SELF INQUIRY (SI), RESIDENTIAL NARRATIVE (R) AND OFFICE SPACE NARRATIVES; (1, 2)

#	Environmental Characteristics / Participant	Number of times comments have fit into this category: SI	R	1	2
01	Accessories (9)	1	8	0	0
02	Adapting (37)	16	7	0	14
03	Air quality (11)	8	0	2	1
04	Air temperature (13)	7	3	3	0
05	Appropriation (26)	8	6	0	12
06	Assurance (2)	1	1	0	0
07	Cognition (22)	1	1	1	19
08	Colour (75)	**21**	**11**	**21**	**22**
09	Comfort (68)	3	14	24	27
10	Community (39)	3	18	6	12
11	Control **(103)**	7	**26**	21	49
12	Crowding (54)	**22**	25	5	2
13	Environmental factors(26)	**7**	**10**	**5**	**4**
14	Ergonomics (43)	2	12	5	25
15	Feelings (95)	**77**	3	8	7
16	Flexibility (88)	4	1	2	81
17	Friendships (27)	20	3	1	3
18	Furniture arrangement (48)	15	28	2	3
19	Geographic situation (87)	3	22	11	3
20	Light **(102)**	29	32	23	18
21	-Artificial	5	0	6	0
	-Daylight	24	32	17	18
	Materials (96)	38	40	16	2
22	Memories (8)	3	4	0	1
23	Nature (92)	38	**29**	0	25
24	Noise (43)	**15**	**4**	4	20
25	Odours (12)	5	0	5	2
26	Ownership (21)	4	10	4	3
27	Pets (6)	6	0	0	0
28	Perception (47)	8	21	15	3
29	Privacy (55)	7	**23**	10	15
30	Relationships (7)	2	2	0	3
31	Relocation (23)	**2**	**6**	**4**	**11**
32	Rooms with story to tell (3)	3	0	0	0
33	Satisfaction **(103)**	**9**	30	33	31
34	Security (43)	25	14	3	1
35	Setting **(118)**	46	31	21	20
	-Architectural	**39**	31	18	14
	-Industrial	1	0	0	0
	-Urban	6	0	3	6
36	Social aspects (88)	11	23	19	35
37	Space characteristics **(292)**	**41**	**147**	51	53
38	Stress (26)	2	0	2	22
39	Style (45)	3	28	0	14
40	Territoriality (24)	13	1	0	10
41	Transportation (48)	3	18	11	16
42	Views (51)	21	**13**	7	10
43	Windows (41)	6	21	8	6
44	Budget (3)	0	3	0	0
45	Preference (23)	0	**22**	1	0
46	Efficiency (11)	0	0	7	4
47	Age (2)	0	0	0	2
48	Feelings of belonging (3)	0	0	0	3

Table 3-2 Environmental Characteristics of Architectural Spaces

Quantitative Research Method: Following the collection of qualitative data on the intangibles of spatial experience using narrative inquiry, a third phase of work focussed on an empirical approach based on the neuroscientific correlates of spatial experience. During this phase a quantitative approach to data collection and analysis was used in order to expand and also to compare findings regarding how intangible environmental characteristics of architectural spaces influence human well-being. The aim of this phase of work was to find ways of accessing human experiential material that could be used to generate additional knowledge on how environmental characteristics of architectural spaces influence, indirectly and implicitly, human well-being.

Fifty-eight office employees responded to neuro-environment assessments in the form of pre- and post-move surveys in order to measure interior design effects on the brain. Employees rated how certain environmental characteristics contributed to their performance and well-being in the office environment. The environmental features that were measured were carefully selected to correlate with the eight brain-based neuroscientific correlates of the key neuroscience concepts of mood, ability to focus attention, and stress (Zeisel, 2006).

Results provided information that was used to design the new office. A second survey was carried out about six months after move-in. A one-day observation session using behavioural mapping techniques at 15-minute intervals was conducted and employees were also interviewed in groups of three to five. Analysis and cross-validation of both pre- and post-move assessments as well as content analysis of observation and group interviews were performed.

A correlation matrix was created using the eight neuroscientific correlates. Results were linked to three neuroscience concepts of mood, ability to focus attention, and stress in order to measure the effects of physical features on brain processes. These concepts have been selected as legitimate neuroscientific categories that can integrate both qualitative and quantitative data because they have been shown to relate directly to the physical environment. Results show that *support and comfort for personal work needs*, which relates

to mood and stress, were rated highest for the new office. On the other hand, *feeling part of a cohesive organization*, which relates to ability to focus attention and stress, were rated lowest in the old office prior to the move.

The study was designed to show how narrative inquiry and neuroscientific research complement each other as ways of finding out more about how architectural spaces influence human well-being in intangible ways. Combining both methods was effective in generating information that designers can apply to their projects. Data collected through narrative inquiries provided the basis from which to begin the research. It allowed the creation of categories generated from environmental characteristics of architectural spaces that together constitute atmospheres that affect users indirectly. This framework was then tested using neuroscientific data from the third phase of the study. By combining the results of the three phases of work, this research gained additional insight as to how intangible aspects, or environmental characteristics, derived from the physical environment affect users' moods.

CATEGORIES OF NEUROSCIENTIFIC RESEARCH

Combining neuroscience / environment / behaviour studies helps to understand the interaction between environmental stimulus and behavioural responses in ways that better inform and improve design (Gage 2003). The brain controls behaviour, and changes in the environment change the brain which affects behaviour. Consequently, architectural design changes the brain and behaviour (Gage 2003) and when spaces do not respond to user well-being, stress, due to constant adaptation, can eventually cause long-term illness.

Neuroscience Concepts of Mood, Focus of Attention and Stress

Data collected in the third phase of the study focuses on three key concepts: mood, focus of attention and stress. These concepts were selected first, because they play a major role in Vischer's (2005) model where energy-in / energy-out is hypothesized that a positive atmosphere (good environment / energy-in) will generate feelings of well-being and therefore less stress and adaptation (bad environment / energy-out) for space users. The

second reason they were selected is because early studies in the area of neuroarchitecture indicate the importance of each in the relationship between people and the built space they occupy.

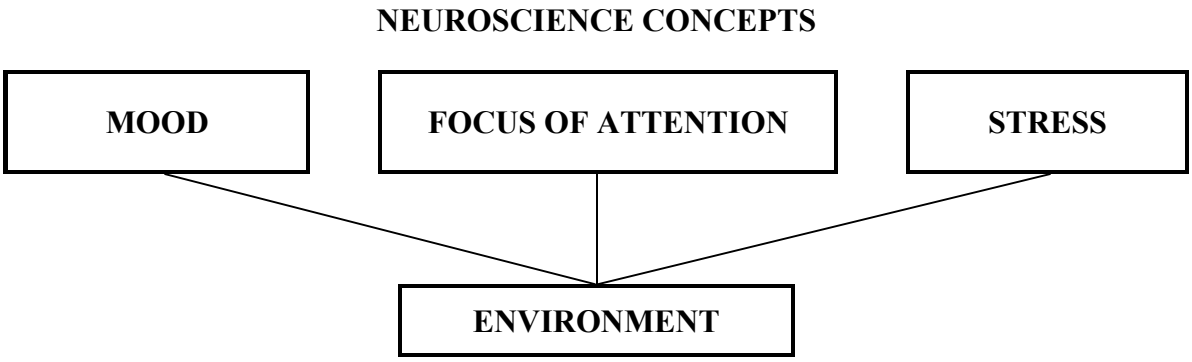

Figure 3-3 Neuroscience Concepts

Figure 3-3, Neuroscience Concepts, illustrates the neuroscience concepts of mood, focus of attention and stress and how they directly relate to the environment. These are well established neuroscientific concepts and were selected because they can be measured behaviourally, respondents can provide reliable data on them and they have provided a framework to prove that setting the right mood for people while conveying a positive atmosphere (good environment / energy-in) will generate feelings of well-being and therefore less stress and adaptation (bad environment / energy-out) to spaces within which they live.

Neuroscientific Correlates

In order to devise an appropriate way to test the concepts of mood, ability to focus attention and stress, Zeisel's (2006) Brain Design Principles, as illustrated in Table 3-3, were applied to measure respondents' behaviours in their workspace and analyse how environmental features in their offices affect them. These are *profound and universal* '*brain*' *design principles* applicable not only for people with Alzheimer's disease to improve their state of mind but also for people in other settings such as offices. These principles relate to basic elements of the space that help Alzheimer patients better orient

themselves within their living environments. If *brain* design principles help improve the lives of people living with Alzheimer's disease they may also be supportive to others who have normal brain states (Zeisel 2006).

BRAIN DESIGN PRINCIPLES			
1	Sense of safety & security	5	Awareness of outdoors and nature
2	Understanding what is expected at work	6	Support and comfort for personal work needs
3	Ability to withdraw & unwind	7	Sense of pride and accomplishment
4	Wayfinding	8	Feeling part of a cohesive organization

Table 3-3 Brain Design Principles (Zeisel 2006)

Elements that link neuroscientific correlates and neuroscience concepts

Table 3-4, Neuroscientific Correlates / Neuroscience Concepts, shows how each of the eight neuroscientific correlates are represented in a manner in which they best predict behaviours related to the neuroscientific concepts of mood, ability to focus attention and stress. This table is illustrated as a means to facilitate assessment of the physical environment's contribution to each of these neuro-scientific behaviours.

NEUROSCIENTIFIC CORRELATES / NEUROSCIENCE CONCEPTS				
Neuroscientific Correlates		Neuroscience Concepts		
		Mood	Ability to Focus Attention	Stress
1	Sense of safety & security	X		X
2	Understanding what is expected at work		X	
3	Ability to withdraw & unwind			X
4	Wayfinding		X	
5	Awareness of outdoors and nature	X		X
6	Support and comfort for personal work needs	X		X
7	Sense of pride and accomplishment	X		
8	Feeling part of a cohesive organization		X	X

Table 3-4 Neuroscientific Correlates / Neuroscience Concepts

Out of the eight neuroscientific correlates, four of them (sense of safety and security, awareness of outdoors and nature, support and comfort for personal work needs as well as sense of pride and accomplishment) are used to measure mood. Three neuroscientific correlates (understanding what is expected at work, wayfinding and feeling part of a cohesive organization) are used to measure ability to focus attention. And, five neuroscientific correlates (sense of safety and security, ability to withdraw and unwind, awareness of outdoors and nature, support and comfort for personal work needs as well as feeling part of a cohesive organization) are used to measure stress.

PROGRESSION OF THE STUDY

Both qualitative and quantitative studies were performed in order to test the Model of Experiential Responses to Space and to prove that intangible aspects of architectural spaces do affect space user well-being. Following is a brief explanation of how each study was performed and how data analysis was supported for each study. Each study is inserted in article format within chapters four, five and six of this thesis. The reasons why the article format was used is explained later in this chapter. Chapter seven is the final chapter which concludes the thesis.

In Chapter 4, Article 1, narrative inquiry is used to identify environmental characteristics contributing to intangible aspects of architectural spaces by means of the Model of Human Experiential Responses to Space, which theorizes that architectural spaces contain environmental characteristics that generate atmospheres which are intangible, affecting user moods and shaping human experience. These environmental characteristics are then used for three other studies to find out if there are any underlying regularities in environmental characteristics that affect user moods and feelings.

In Chapter 5, Article 2, neuroscientific correlates of architectural space are used to analyze empirical data to provide more detailed knowledge on how architectural spaces influence brain behaviour. The research is based on theoretical frameworks including Alexander's (1979) approach to subjective human feelings, Vischer's (2005)

Environmental Comfort Model of User Space Interaction, and Zeisel's (2006) eight deep healing design principles used for Alzheimer patients.

In Chapter 6, Article 3, results of both studies (Chapter 4-Article 1 and Chapter 5-Article 2) are combined in order to discover ways in which qualitative and quantitative data that both measure human brain processes in relation to occupying built space could complement each other. The goal is to inform and enrich our understanding of the intangible aspects of architectural spaces by integrating qualitative and quantitative data.

The integration of both research approaches help understand what makes people feel the way they do in architectural spaces. It reveals that people's moods may be affected similarly in residential or office space settings and that a good environment that energizes employees will affect their work performance in a positive way (Vischer 2005). Results suggest that neuroscience / human-behaviour / built-environment interrelationships can be regarded as means to better meet human needs. Environmental characteristics shape the patterns of people's behaviour (Pilatowicz 1995), impact on the human brain (Zeisel 2006) and affect people's mood, ability to focus attention and stress level.

Chapter seven concludes the thesis by highlighting the ways in which the results of this research contribute to filling the knowledge gap identified within the Interior Design Body of Knowledge (Guérin and Martin 2004). Human needs are addressed through the lenses of human behaviour / built environment frameworks.

Similarities, differences, strengths and weaknesses of both narrative inquiry and neuroscientific research methods are addressed as well as the importance of this research and its applications to design. The originality and contribution of this study are explained as well the importance of building ties between design and research professionals in order to further research that contributes to knowledge base in interior design.

THE THESIS IN ARTICLE FORMAT

The reasons for presenting this thesis by article are as follows: First, the goal is to contribute to the Interior Design Body of Knowledge (Guérin and Martin 2004) by publishing a scientific research article that can be read by members of the profession; and second, publication is a connection between the world of academia and the world of practice, and encourages interior designers to use their experience as a basis for their research.

Published research is above all a contribution to the advancement of science, where the world can benefit from inventions, ideas and advances that have evolved from research initiatives. But to attain this objective, the contribution must be known and therefore the new knowledge must be transmitted to society in order to contribute to quality of life. One of the best ways to transmit this knowledge is by publishing articles in scientific journals. Undertaking this route means that the article has been peer-reviewed, and therefore evaluated and accepted by content experts, and new knowledge can be easily available to the community through publications (Dubois 2005).

DISCUSSION

This research confirms that architectural spaces are composed of several environmental characteristics that generate atmospheres which affect user moods and shape human experiential responses. Based on the Model of Human Experiential Response to Space as shown in Figure 3-1 and on Vischer's (2005) Environmental Comfort Model of User-Space Interaction: the Comfort-Productivity Continuum as shown in Figure 3-2, the two following hypotheses form the core of this research: *People's moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit*; and *setting the right mood for people while conveying a positive atmosphere will generate feelings of well-being and therefore less stress and adaptation to spaces within which they live*.

Narrative inquiry, neuroscientific correlates and neuroscience concepts were used to identify intangibles and how they affect human well-being. Certain environmental characteristics are directly - or indirectly - linked to the eight neuroscientific correlates and to Abbate's (2005) key attributes of successful places. For example: Sense of safety and security can be linked to environmental characteristics such as *appropriation, assurance, comfort, control, ownership,* and *security* and relates to Abbate's key attribute of *comfort and image* which is linked to *safety*, as illustrated in Table 1-2; and Support and comfort for personal work needs can be linked to environmental characteristics such as *air quality, air temperature, budget, crowding, efficiency ergonomics, flexibility, furniture arrangement, light (artificial / daylight), materials, privacy, rooms with a story to tell,* and *space characteristics* and relates to Abbate's key attribute of *comfort and image* which is linked to *charm and attractiveness*.

The 48 environmental characteristics derived from the narrative inquiry are closely linked to neuroscientific correlates and each method of inquiry helped to corroborate results whereby environmental characteristics may be used to measure space-user moods, ability to focus attention and stress. The environmental characteristics and neuroscientific correlates are also linked to Abbate's (2005) key attributes of successful places making it possible to link qualitative and quantitative research methods. Research results derived from qualitative data can enrich and validate research results derived from quantitative data. This is evidence that *sense of place* can be used to link both the qualitative and quantitative research methods used in this research.

The research has been successful in providing preliminary validation of the Model of Experiential Responses to Space which indicates some of the ways intangibles affect human experience.

In the first study, narrators were able to express what elements of architectural spaces influenced how they felt architectural space affected their moods over a long time span. Research results provided a basis from which to prove the hypothesis that *people's moods and emotions are affected by elements of the space they occupy in ways that are*

neither direct nor always explicit and that such intangibles can be identified by analysing qualitative data derived from narrative inquiry. This data could be retained for future use as individuals who narrated their stories will remember and recognize which environmental characteristics of architectural spaces influence their well-being.

In the second study, research results derived from the old offices of the SfN offices also provided valuable insights to space planners before the planning phase began for the new office location. Results from the research provided a basis from which to prove the hypothesis that *setting the right mood for people while conveying a positive atmosphere will generate feelings of well-being and therefore less stress and adaptation to spaces within which they live*. Results from this research have demonstrated that research regarding human behaviour / built environment interrelationship and interior design experience go hand in hand. Combining research findings to design solutions prior to the space planning phase offers tremendous value to creating spaces that gear toward space-user self-fulfillment.

This research contributes to filling the gap within the Interior Body of Knowledge (Guérin and Martin, 2004) and to enhancing the health, safety and welfare benefits to the public. And, as researchers continue to investigate the subjects of human factors and human behaviour /built environment relationships while working hand-in-hand with design professionals, this will help to continue to advance the profession of Interior Design.

CHAPTER 4 – ARTICLE 1

TITLE

USING NARRATIVE INQUIRY TO IDENTIFY
INTANGIBLE ASPECTS OF ARCHITECTURAL SPACES

AUTHOR

Odette Côté

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USING NARRATIVE INQUIRY TO IDENTIFY
INTANGIBLE ASPECTS OF ARCHITECTURAL SPACES

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BIOGRAPHICAL DETAILS

Odette Côté has both a college and university degree in interior design and has been practicing in this field for the last thirty years. She also a bachelors and masters degree of architecture from the University of Montréal and is performing research to find out what intangible aspects of architectural spaces enhance human well-being. She has taught interior design for twenty years at college and university levels, was department coordinator of the Interior Design program at Cégep Saint-Jean-sur-Richelieu in the province of Québec, Canada and is now Faculty Dean for Social Sciences, Commerce, Arts & Letters at Vanier College in Montréal also in the province of Québec, Canada.

ABSTRACT

Narrative inquiry is used to identify intangible aspects of architectural spaces by means of the Model of Human Experiential Responses to Space. This model theorizes that architectural spaces contain environmental characteristics that generate atmospheres which are intangible, affecting user moods and shaping human experience. Evidence of human responses to spaces can be useful for space planners in order to define what best suits user needs before the design process begins (Alexander 1979).

Results of a self-inquiry depict 43 categories that are laid down to identify intangible aspects of architectural spaces that influence human well-being. These categories are then used for three other studies to find out if there are any underlying regularities in environmental characteristics that affect user moods and feelings.

The results of data analysis are interpreted, and a comparative analysis is performed. Results show that similar environmental characteristics suit the needs of space users in order to heighten sense of satisfaction and well-being for both residential and office space users.

A discussion is built around the Model of Human Experiential Responses to Space and its purpose as a tool to unearth environmental characteristics that enhance well-being. This model can also be of value to design professionals.

KEY WORDS: Architectural Spaces, Intangible Aspects, Human Well-Being.

INTRODUCTION:

Architectural spaces project meanings (Csikszentmihalyi, M. and E. Rochberg-Halton 2002). They shape and structure human behaviours as well as direct human consciousness towards their own sense of self and being (Pallasmaa 2005). The relations that bind us to the spaces we inhabit are among the most significant in our lives (Serfaty-Garzon 1999).

Alexander's (1979) notion of human feelings about architectural spaces sets a theoretical framework for the present study. Using narrative inquiry as a tool, the Model of Experiential Responses to Space exemplifies that architectural spaces are composed of environmental characteristics that generate atmospheres which are intangible, affecting user moods and shaping human experiential responses to space. This model serves as a framework to test the hypothesis that people's moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit. Evidence of human responses to spaces can be useful for space planners in order to define what best suits users' needs before the design process begins (Alexander 1979).

Four case studies are presented where each participant narrates personal experiences of interior atmospheres and moods in spaces where they have lived and worked within an approximate 25-year span. Data from both residential and office space narratives are compared in order to find out if similar environmental characteristics influence human well-being.

Narrative inquiry helps to raise awareness and takes into account expression of feelings. When participants describe their needs, they help guide the process of growth in an environment and also help shape it (Alexander, Sylverstein, et al. 1975). Their life so narrated can have a symbolic and cognitive value (Denzin and Lincoln 2005). Therefore what people can verbalize and express about themselves within their surroundings may then be used as data for space planners who wish to design spaces for user well-being (Zeisel 2006).

Study results are used to test the model of Experiential Responses to Space and hypothesis. Study outcomes also contribute to the interior design profession's body of knowledge (Guérin and Martin 2004).

DESIGNING SPACES FOR HUMAN WELL-BEING

The idea of comfort has changed dramatically over the years, going from privacy in the seventeenth century, to leisure and ease in the eighteenth century, to light, heat and ventilation in the nineteenth century, to efficiency and convenience in the twentieth century (Rybczynski 1986). Space has a critical effect on people's comfort and well-being.

Today, man is in a network of relationships which matter only to him (Merleau-Ponty 2004). The shape of a building has an effect on the relative degrees of privacy in it (Alexander 1979) and overcrowding causes psychological and social damage (Landler 1954; Loring 1956; de Lauwe 1959, Alexander, Ishikawa et al. 1977).

Well-being refers to optimal psychological functioning and experience (Ryan and Deci 2001). It is a complex construct where the *hedonic* approach pertains to happiness, attainment of pleasure and avoidance of pain, while the *eudaimonic* approach refers to meaning and self actualization or the degree to which a person is fully functional (Ryan and Deci 2001). Maslow (1943) depicts five categories of needs (physiological, security, social, ego and self-actualization) which people require in order to realize their full potential or reach a state of complete satisfaction.

Little is known about peoples' attachment to spaces or the way spaces become incorporated in the experiences of persons (Csikszentmihalyi, M. and E. Rochberg-Halton 2002). Merleau-Ponty (1968) refers to the invisible substructure of the visible as being the key to the unconscious structure of consciousness. Can it be possible then that there are invisible, intangible substructures of the visible, tangible aspects of architectural spaces? That both the intangible and tangible aspects form a whole which can act on an individual's unconscious self which they can then express as feelings of contentment or dissatisfaction?

If so, then intangible aspects of architectural spaces may be a useful way to explore those aspects of architectural spaces that influence human well-being.

Several studies aim at identifying singular, tangible aspects of architectural spaces that influence human well-being. For example, Ainsworth and Simpson (1993) examined three groups of 15 female participants for the effects of three hues on performance and mood while in an office work environment. Boubekri and Hull (1991) investigated the impact of window size and different amounts of sunlight penetration on forty office workers' emotional responses and degree of satisfaction. Knez and Enmarker (1998) investigated the effects of office lighting on male and female adults' mood and cognitive performance in the physical setting of an office. McColl and Veitch (2001) investigated full-spectrum fluorescent lighting and its effects on behaviours, mental health outcomes and physical health effects, as compared to other fluorescent lamp types.

These studies, among others, do not address the invisible aspects that surround the visible, tangible aspects of architectural environments. They do not take into account that several environmental characteristics are present in a setting where behaviour is being measured and may also influence the mood of participants. Without doubt, invisible, intangible aspects affect all situations, including those where visible, singular aspects of architectural spaces and their impact on space users are being studied.

Using a holistic approach, the objective of this research is to take an inclusive approach to find intangible aspects of architectural spaces that influence human well-being. These include:

> -those aspects that make a space lived in, alive, that form the heart of the space. For example the corner of a room where two walls meet can become a haven or a special place in that room where one can retreat, contemplate and regenerate (Alexander, Ishikawa, et al. 1977). That space becomes a special place to withdraw into ourselves (Bachelard 1994);

-those aspects that highlight concealed features of some of the important themes of our lives (de Botton 2006). For example, art work or at home, furniture that give us an opportunity to focus on the powers of objects and the underlying meanings they bring us;

-those aspects that tell us of certain moods and speak of visions of happiness. For example, a design object which gives a feeling of beauty and brings us to certain ideas of a good life (de Botton 2006).

If spaces are to be designed from the users' perspective in order to increase comfort and satisfaction as well as optimize human welfare (Ulrich 1992, Vischer 2005), then understanding the impact of interior environments on space users is of crucial importance.

METHODOLOGY

Since the quality of office space is increasingly recognized as one of the determining factors guiding efficiency, productivity and even the morale of office workers (Fischer and Vischer 1998), this may also hold true for people occupying residential, or any other type of space.

In order to identify the intangible aspects of architectural spaces that enhance the well-being of humans and how these can enhance a person's mood, satisfaction and long-term well-being, narrative inquiry is used for this study. Due to the collaborative experience that it entails, both the voices of the narrator and the researcher are heard (Marshall and Rossman 1999). This method adds a great deal to '*authentic research*' as the information comes directly from the narrator's story (Connelly and Clandinin 1990).

Narrative inquiry was selected because as narrators explain, entertain, inform, defend, complain, and confirm or challenge the status quo in their own words, reality is shaped and formed around them (Chase 2005). Each story is authentic and brings forth some of most urgent issues that confront people today (Danko, Portillo et al. 1999). Narrative inquiry was also selected for this study because narrations of life stories provide data derived from

social phenomena and the results obtained depend on the discussion between both the narrator and researcher and on the content analysis of the stories told (Mucchielli 2004). Furthermore, when inquiring about architectural space, narratives add depth and breadth to the understanding of how the environment is psychologically inhabited by the individual (Ganoe 2000). Narratives also help uncover sight, touch and smell as elements of satisfaction that affect user well-being (Abercombie 1990).

It is difficult to identify specific aspects that make a space feel '*right*' or not. Users respond to entire atmospheres composed of aspects such as colours, furniture arrangements, ceiling heights, views to the outdoors, nature, etc. So '*how*' can such human experiential material be accessed to discover what makes humans feel the way they do in the spaces in which they inhabit?

The first step of the study was a self-inquiry from the narrator who is the author of this research. She first listed elements of the atmospheres that she felt affected her mood, satisfaction and well-being over the last 45 years. These experiences ranged from when she was a child to adulthood, and in different homes where she had lived, schools that she had attended and places where she had worked.

The personal narrative was then broken into meaningful analytic groups by classifying each statement according to key words produced by the narrator. These key words best represented how the author felt atmospheres, generated through environmental characteristics, had affected her mood and well-being over the years. The keywords were then used to create 43 categories representing environmental characteristics of architectural spaces. These provided a framework within which to analyse additional narratives.

For example, in the self-inquiry the narrator states that one of the residences that she had lived in was:

> '*…where I first felt the goodness of a space. I was in a good mood and felt happy all the time. There was plenty of space, plenty of sunlight, plenty of views to the outside*'.

This statement characterizes the narrator as being in a good mood which may be attributed to such intangible environmental characteristics as *space characteristics*, *daylight* and *views.*

The narrator also states that:

> '*I cannot accommodate more than four people in my home otherwise I feel crowded and suddenly get very tired and out of breath*'.

This statement highlights the narrator's *feelings* of *crowding* which don't contribute to her sense of well-being.

The theoretical Model of Human Experiential Responses to Space as shown in Figure 4-1 was devised in part to explain the results. The model illustrates that architectural spaces are composed of several environmental characteristics, derived from the 43 categories, found in the author's personal narrative. Together, these environmental characteristics generate atmospheres that are intangible. The resulting atmospheres generated from environmental characteristics affect user moods and shape human experience. These responses can then be expressed as feelings of satisfaction and well-being or as feelings of discomfort which can lead to stress.

It must be noted that The Model of Human Experiential Responses to Space is not to be regarded as a global model of human environment relations, but rather as a testable model of environmental intangibles. This model presents a dynamic process and demonstrates that multiple aspects of interior spaces have shaped, and will continue to shape, space users' reactions, which in turn affect people's long-term well-being. Based on this model the following hypothesis was identified:

> Since people's moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit, such intangibles can be identified by analysing qualitative data derived from narrative inquiry.

The only way to know how people see and feel about the world is by asking (Zeisel 2006). In order to test the hypothesis, categories from the initial self-inquiry of how intangible aspects of architectural spaces influence well-being were used for the narratives of the three other participants: first, with findings from a 47-year-old female whose narration is based on residential interiors where she has lived in several cities around the world; then, with those of two participants of approximately the same age (between 40 and 50) who have worked in different offices.

A small sample was selected because of the rich and voluminous data yielded in each case. The amount of qualitative data rather than the number of respondents was deemed more relevant to testing the hypothesis. Analysis of the data was designed to enhance and enrich the framework for further studies in this area. The aim was to determine how all four participants felt environmental characteristics may have affected their moods and feelings over the years in different residential and office space settings. Results were used to test the hypothesis that environmental characteristics influence the well-being of humans can be similar from one narrative to another and among different settings. Results were also used to test the application of the Model of Human Experiential Responses to Space.

This method is a dynamic process where data from further research may be used to test the Model of Human Experiential Responses to Space in order to solidify, modify and enhance it. The goal is to find common elements at the intangible level of spatial experience that is common no matter the age, gender, preference or cultural background of space users.

In this study, the selection criterion for the three participants was that they needed to have experienced different residential or office space settings during at least twenty years. This criterion matches the time span of the author's personal narrative. To ensure participation, it was important to involve participants that had the necessary time available to narrate their life story in terms of the residential or office environments that influenced their lives. It was also important to make sure that participants willing to participate in the study had the ability to express elements that are essential for the research.

Prior to participating in the research, participants were asked to read and sign a consent form advising that their participation was on a voluntary basis, that the information provided through their narrations was confidential, that they had the right to withdraw at anytime by advising the researcher verbally and that any data collected at the moment of withdrawal would be destroyed.

Participants were also told that the objective of this research was to better understand how narratives can be used to generate knowledge on how architectural spaces influence human well-being and how elements of the environment affect peoples' moods and feelings. They were told that this research explores how environmental characteristics can contribute to human well-being and that the aim was to understand more about the predicted consequences of design decisions on human experience.

Participants were asked to recount their life story in terms of:

- How elements of their physical environment had influenced their feelings of well-being over the years;
- How their moods and emotions might have been affected by elements of spaces they occupied;
- How they felt the general atmosphere generated by environmental characteristics of architectural spaces had contributed to their overall satisfaction and contentment.

All the narrations were tape recorded and lasted between one to two hours. Interviews to conduct the narrations took place in the home of the residential narrator and at the office narrators' place of work.

The recorded narratives were transcribed into Word documents, saved as RTF files and then transferred to an Atlas-ti program used for qualitative data analysis. During this phase, each file was analyzed separately and each narrated sentence was coded into one of the 43 categories that represented environmental characteristics generated from the initial self-inquiry. Inverse coding was performed, where each of the sentences was placed in its respective coded category. The resulting Codes-Quotation List was then printed and

verified. A Codes-Primary-Documents-Table was then created using Atlas-ti and was printed in order to interpret results. Although every narrative is different, data analysis shows how environmental characteristics commonly affect moods, satisfaction and long-term well-being.

RESULTS

The Environmental Characteristics of Architectural Spaces, shown in Table 4-1, illustrates results from all four narratives. Each participant is identified by an abbreviation where *SI* represents the findings from the researcher's self-inquiry, *R* signifies the findings from the narration based on residential interiors, then *1* and *2* represent the findings from participant (1) and participant (2) derived from the office narratives.

As mentioned, the first 43 categories representing environmental characteristics were initiated from the author's self-inquiry. Then, *budget* and *preference* were added during data analysis from the residential narrative (*R*). *Preference* emerged from participant (1)'s data analysis as did *efficiency*. *Age* and *feelings of belonging* emerged from participant (2)'s data analysis. These five categories are found at the end of the table and are numbered between 44 and 48.

Table 4-1, Environmental Characteristics of Architectural Spaces, lists in bold characters the number of times environmental characteristics were most often mentioned by the four narrators. They represent those characteristics they felt most influenced their mood and degree of satisfaction in architectural spaces. These are *control* (103), *light* (102), *satisfaction* (103), *setting* (118), and *space characteristics* (292). Numbers in parentheses indicate the number of times these characteristics were mentioned by all four narrators.

The following quotes derived from the narratives show what kinds of statements were assigned to specific categories. For example, when participant (SI) mentioned '*I always felt good in that home*' or '*the rooms felt cold*', these comments were categorized under *feelings*. When participant (1) mentioned '*the luminosity from the outside is good when you have the sun*', this comment was categorized under *light-daylight*. When participant (1)

mentioned '*we had lamps and stuff like that*', this comment was categorized under *light-artificial*.

Characteristics that vary the most from one narrator to another as to the number of times that they have been mentioned by each participant are *feelings*, *flexibility* and *space characteristics*. *Feelings* was most often mentioned by participant (SI), *flexibility* was most often mentioned by participant (2) in the office narrative, and *space characteristics* was most often mentioned by participant (R).

Characteristics that were mentioned similar amounts of times by the four participants are *colour*, *environmental factors* and *relocation*. *Pets* and *rooms with a story to tell* were categories only articulated by participant (R) whereas *efficiency* was only expressed by participants (1) and (2).

Data from participant (SI) reveals that environmental characteristics of architectural spaces that were mentioned most often as contributing to participants' overall satisfaction and contentment are *feelings* and *space characteristics*. Environmental characteristics that were most often mentioned by participant (R) are *materials* and *space characteristics*. Data from participant (1) reveals that *color*, *comfort*, *control*, *light*, *satisfaction*, *setting*, and *space characteristics* were mentioned most often. On the other hand, data from participant (2) reveals that *adapting*, *cognition*, *comfort-discomfort*, *control*, *ergonomics*, *flexibility*, *nature*, *noise*, *satisfaction*, *social aspects*, *space characteristics* and *stress* were mentioned most often.

DISCUSSION

The Model of Human Experiential Responses to Space shown in Figure 4-1 provided a framework for the present study. Data derived from the four narratives reveal how multiple aspects of architectural spaces shape human behaviour and affect their long-term well-being. The analysis provides support for the hypothesis that people's moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit.

First of all, in regards to *strength of feelings* towards environmental characteristics, participant (SI) mentioned that *crowding* and *noise* were elements that bothered her the most in an architectural setting. She felt that *privacy* was important for her and she said that she likes to avoid *noisy* neighbourhoods. On the other hand, she stated that *space characteristics, materials, views to the outside*, *nature* and *preference* are important.

Data from participant (1) and (2) in the office space narratives show that both of them felt *space characteristics* improved their degree of *satisfaction* in the last office they occupied. Their office no longer had bad *odours*, it had *natural light*, and better *views* to either the outdoors or to a garden. Both of their dream offices would have *views* to the outdoors as essential elements for them to feel regenerated. Furthermore, both participants wished to have easy *transportation* to work. Derived from their narratives, these environmental characteristics are the ones they would wish to have in order to *feel* better in the spaces within which they work.

Results also show that *space characteristics* and *views* to either the outdoors or to a garden or nature were environmental characteristics that were similar for both residential and office space narrators. These environmental characteristics can then be said to influence peoples' moods, satisfaction and well-being in both residential and office spaces. On the other hand, results show that differences in environmental characteristics that affect user well-being do appear among narrators with the same type of setting. Differences may correlate with specific tasks that each person must carry out.

For example, data from participant (1) revealed his discomfort in humid, polluted and noisy workspaces. His sensitivity towards this type of space made him feel uncomfortable. Since he requires a closed office where he can work without being disturbed for hours at a time, *space characteristics* and *materials* in his office may be desired elements for his comfort and well-being. This explains why *color*, *comfort*, *control*, *light*, *satisfaction*, *setting*, and *space characteristics* were mentioned most often in his narrative.

On the other hand, results show that participant (2) enjoys having lots of windows, views to the outdoors and being surrounded by people at the office. Being in charge of a team at work, her preference to be surrounded by employees helps her monitor their office projects. Since she works in an open space to oversee team work, she needs to have control over her space, must adapt to constantly changing situations, and needs to listen to what her employees say when they share information. At the same time, she needs time to think and be productive. This may explain why *adapting*, *cognition*, *comfort-discomfort*, *control*, *ergonomics*, *flexibility*, *nature*, *noise*, *social aspects*, *space characteristics* and *stress* were environmental characteristics that were mentioned several times in her narrative. These characteristics may be said to be intangible as they are not physical elements of the spaces themselves, but rather result from several environmental characteristics that generate atmospheres that affect human feelings towards that space.

These should not be regarded as simple user preferences on which so much previous research has focussed, but instead, as the effects of *intangibles*. For example, a person hears noise; a person can feel satisfaction or stress; and a person can feel comfort and control. These are the intangibles that emerge as important in this research; those aspects of architectural spaces that envelop us each day; those that affect our moods, satisfaction and well-being and that are neither direct nor explicit.

What one *feels* could be elements affecting one's well-being should be considered as essential and valuable data from which space planners can work with in order to plan spaces that are geared towards human well-being (Alexander 1979). Considering intangible aspects of architectural spaces may unveil answers to basic elements of comfort and satisfaction that few scientific studies have provided so far. Spaces are composed of solids and voids and it is not because we cannot see the intangible voids that they are not essential elements of the spaces we inhabit. After all, the intangible parts of the spaces within which we live are far greater in volume than the tangible parts. What we cannot touch or see, we may be able to feel, hear or smell. And it is by listening to space users through narrative

inquiry that significant data can be unveiled as to how they '*feel*' spaces have an effect on them.

Due to the multi-faceted complexity of each environmental characteristic, architectural spaces must be seen as complex entities acting upon complex human beings who have their own needs and desires. Spaces are composed of numerous elements that, combined, affect human well-being. This may be the reason why spaces make people *feel* (Alexander 1979) the way they do in ways that are neither direct nor always explicit.

Although there are many tangible, physical aspects in architectural environments, it is the combined effect of tangibles and intangibles that affect behaviour. The present study proposes the Model of Experiential Responses to Space as a useful tool for holistic inquiries into the human response to architectural space. The model illustrates that architectural spaces are composed of multiple environmental characteristics that, together, generate atmospheres that are intangible. These atmospheres shape peoples' moods and well-being.

This model is a dynamic system as each of its components can vary and each component responds to the others. Buildings vary from one country or city to another, as do space occupants depending on factors such as age, gender, culture and preference. Intangible aspects of architectural spaces therefore constitute a whole array of unknowns that are essential to good design. The goal is to find commonalities of varied experiences so that space planners may use research data to find design solutions that are essential to all human well-being.

The study also shows how environmental characteristics of architectural spaces refer to an architecture that fuses the intangible and the tangible for users, so that they are in conjunction and not in opposition (Hill 2006). For example, an empty room does not portray the same atmosphere as one which has a table, a light, a window showing views of nature, the sound of music and the smell of roses. Intangible and tangible architectural characteristics together can be positioned in a way that the resulting atmosphere can be

enjoyable and conducive to human well-being. Further research to discover more about which intangible aspects of architectural spaces enhance human well-being may provide data revealing basic necessities for everyone, regardless of age, gender or culture.

CONCLUSIONS

Narratives not only communicate the narrator's point of view, but also his thoughts, feelings and interpretations. This form of qualitative research can be viewed through multiple lenses; researchers consistently interchange these connected lenses as they listen, collect and interpret data as well as when they interpret the narratives (Chase 2005). In this study, narratives from four participants were used to identify intangible aspects of architectural spaces. Narrative data analysis led to outlining a theoretical framework in the form of the Model of Human Experiential Responses to Space that explains key relationships between users and environmental intangibles.

Data from participants were easily classified into the table of 43 categories representing environmental characteristics identified as intangible aspects of architectural interiors, and analysis helped demonstrate that all participants are affected by such characteristics. Though additional research may further enhance the list of '*intangible*' categories, this study shows that the 43 used here form a core for further research. Though environmental conditions vary in differing settings, humans express similar feelings towards the spaces which they occupy both at home and at work. Study results also supports the hypothesis that people's moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit and that such intangibles can be identified by analysing qualitative data derived from narrative inquiry. Furthermore, environmental characteristics that influence the well-being of humans can be similar from one narrative to another and among different settings.

An increasing number of practice-based disciplines are embracing narrative inquiry as a powerful means of teaching the more intangible, human-centred issues of professional practice (Danko, Meneely et al. 2006). Captured voices of end-users not only focus on subjective reality, they also make individual perspectives explicit (Danko 2003).

Furthermore, in relation to the theoretical Model of Human Experiential Responses to Space, results from the narrated case studies demonstrate that it is not only a single environmental characteristic within architectural spaces that affect human well-being but rather a combination of several environmental characteristics together that generate intangible atmospheres.

The results of this study open up inquiry into the intangible ways in which an individual feels about, perceives, or otherwise reacts to a particular environment or situation (Zeisel 2006). It contributes to the interior design profession's body of knowledge where there is a knowledge gap pertaining to the experience part of the Career Cycle in reference to human behaviour and human factors within interior environments (Guérin and Martin 2004). This research also demonstrates that tangible and intangible environmental characteristics enhance human well-being and affect productivity.

Since humans generally spend most of their time in interior environments, it is essential that spaces be in symbiosis with their occupants (Serfaty-Garzon 1999). The Model of Experiential Responses to Space, though relatively new, is supported by the four case studies set forth in this research. It can be used as a model for practice-based expertise as a holistic way of finding out WHAT it is about the environment that makes people *feel* (Alexander 1979) the way they do. Using narrative inquiry, the results of such studies are particularly useful for professionals who design spaces that are geared towards human well-being.

Just as it is important to test pharmaceutical products for their side effects before they are given to humans, it is just as important that research be done to understand how humans are affected by environmental characteristics before designers can create buildings that meet human needs. Therefore, this thesis not only looks at environment-behaviour research but specifically seeks to find implicit (intangible) ways in which human behaviour is affected by architectural settings. Data from human responses to architectural spaces can be useful for space planners during the design process in order to define in advance what best suits user needs (Alexander 1979).

Atmospheres shape each and every person that inhabits architectural spaces and can influence long-term well being if spaces are designed in accordance with human welfare. Therefore, human experiential responses to architectural spaces, expressed as feelings of well-being or as feelings of stress and adaptation, provide data that professionals can use to further develop architectural spaces that are conducive to human needs.

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ENVIRONMENTAL CHARACTERISTICS OF ARCHITECTURAL SPACES

COMPARING SELF INQUIRY (SI), RESIDENTIAL NARRATIVE (R) AND OFFICE SPACE NARRATIVES; (1, 2)

#	Environmental Characteristics / Participant	Number of times comments have fit into this category: SI	R	1	2
01	Accessories (9)	1	8	0	0
02	Adapting (37)	16	7	0	14
03	Air quality (11)	8	0	2	1
04	Air temperature (13)	7	3	3	0
05	Appropriation (26)	8	6	0	12
06	Assurance (2)	1	1	0	0
07	Cognition (22)	1	1	1	19
08	Colour (75)	**21**	**11**	**21**	**22**
09	Comfort (68)	3	14	24	27
10	Community (39)	3	18	6	12
11	Control **(103)**	7	**26**	21	49
12	Crowding (54)	**22**	25	5	2
13	Environmental factors(26)	**7**	**10**	**5**	**4**
14	Ergonomics (43)	2	12	5	25
15	Feelings (95)	**77**	3	8	7
16	Flexibility (88)	4	1	2	81
17	Friendships (27)	20	3	1	3
18	Furniture arrangement (48)	15	28	2	3
19	Geographic situation (87)	3	22	11	3
20	Light **(102)**	29	32	23	18
21	-Artificial	5	0	6	0
	-Daylight	24	32	17	18
	Materials (96)	38	40	16	2
22	Memories (8)	3	4	0	1
23	Nature (92)	38	**29**	0	25
24	Noise (43)	**15**	**4**	4	20
25	Odours (12)	5	0	5	2
26	Ownership (21)	4	10	4	3
27	Pets (6)	6	0	0	0
28	Perception (47)	8	21	15	3
29	Privacy (55)	7	**23**	10	15
30	Relationships (7)	2	2	0	3
31	Relocation (23)	**2**	**6**	**4**	**11**
32	Rooms with story to tell (3)	3	0	0	0
33	Satisfaction **(103)**	**9**	30	33	31
34	Security (43)	25	14	3	1
35	Setting **(118)**	46	31	21	20
	-Architectural	**39**	31	18	14
	-Industrial	1	0	0	0
	-Urban	6	0	3	6
36	Social aspects (88)	11	23	19	35
37	Space characteristics **(292)**	**41**	**147**	51	53
38	Stress (26)	2	0	2	22
39	Style (45)	3	28	0	14
40	Territoriality (24)	13	1	0	10
41	Transportation (48)	3	18	11	16
42	Views (51)	21	**13**	7	10
43	Windows (41)	6	21	8	6
44	Budget (3)	0	3	0	0
45	Preference (23)	0	**22**	1	0
46	Efficiency (11)	0	0	7	4
47	Age (2)	0	0	0	2
48	Feelings of belonging (3)	0	0	0	3

Table 4-1 Environmental Characteristics of Architectural Spaces

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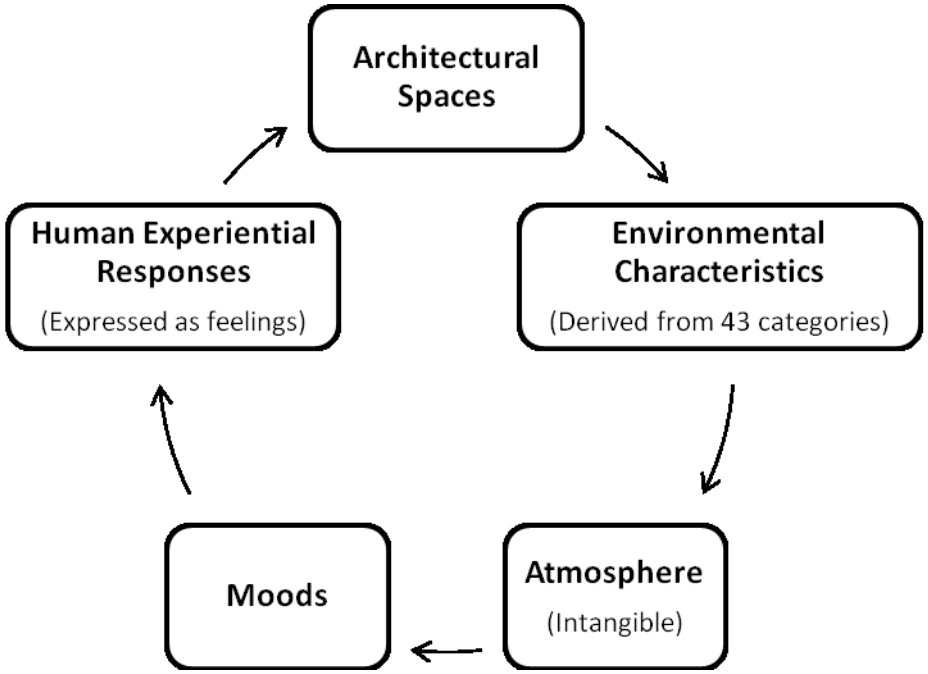

Figure 4-1 Model of Human Experiential Responses to Space

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CHAPTER 5 – ARTICLE 2

TITLE

NEUROSCIENTIFIC CORRELATES OF ARCHITECTURAL SPACE:
A Case Study of Space for Work

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ABSTRACT

This study analyzed empirical data to provide more detailed knowledge on how architectural spaces influence brain behaviour. The research is based on theoretical frameworks including Alexander's (1979) approach to subjective human feelings, Vischer's (2005) Environmental Comfort Model of User Space Interaction, as well as Zeisel's (2006) eight deep healing design principles used for Alzheimer patients.

In order to measure interior design effects on the brain, fifty-eight office employees, before and after moving into new office premises, responded to neuro-environment assessments in the form of pre- and post-move surveys. Employees rated how certain environmental characteristics contributed towards their performance and well-being in the office environment. The environmental features that were measured were carefully selected to correlate with the eight brain-based neuroscientific correlates (Zeisel, 2006) that affect the key neuroscience concepts of mood, ability to focus attention, and stress. Results provided information that was used to design the new office.

In addition to the surveys, a one-day observation session using behavioural mapping techniques at 15-minute intervals was conducted. Employees were also interviewed in groups of three to five. Analysis and cross-validation of both pre- and post-move assessments as well as content analysis of observation and group interviews were performed.

A correlation matrix was created using the eight neuroscientific correlates. Results were linked to three neuroscience concepts of mood, ability to focus attention, and stress in order to measure the effects of physical features on brain processes. Results show that 'support and comfort for personal work needs', which relates to mood and stress, were rated highest for the new office. On the other hand, 'feeling part of a cohesive organization', which relates to ability to focus attention and stress, were rated lowest in the old office prior to the move.

KEY WORDS: Architectural Spaces, Human Well-Being, Neuroscientific Correlates, Environmental Psychology

INTRODUCTION

The field of neuroscience and architecture is the merging of two disciplines being investigated by both architects and neuroscientists. The goal is to explore how the human brain can be impacted by architectural spaces, to determine why humans perceive and respond to the built environment, and to provide data for designers so they can design better spaces. By measuring how architectural spaces affect the brain, research can be used to predict consequences of design decisions and to support design proposals that enrich human experience (Zeisel 2006).

Several research findings, such as colour or light, have been sought for individual aspects of architectural spaces that influence human well-being. For example Ainsworth, Simpson et al (1993) examined three groups of 15 female participants for the effects of three hues on performance and mood while in an office work environment. Others investigated the impact of window size and different amounts of sunlight penetration on forty office worker's emotional responses and satisfaction (Boubekri, Hull et al. 1991). Furthermore, Knez and Enmarker (1998) investigated the effects of recommended office lighting on male and female adults' mood and cognitive performance in the physical setting of an office. These aspects of interior spaces are useful in finding out how peoples' performance or mood can be affected by individual environmental characteristics. Since humans are affected by all aspects of a space, a more holistic approach is needed. Spaces are composed of multiple architectural characteristics that together, affect user feelings, moods and behaviours.

A good environment that energizes employees will affect their work performance in a positive way (Vischer 2005). An environment that is conducive to energizing space users may also result in good mood and ability to focus attention. Therefore, architectural spaces have an influence over our state of mind (Zeisel 2006, Eberhard 2007). Relying on subjective feelings as a scientific approach (Alexander 1979) and using a holistic approach to find out how people feel about the spaces within which they live may provide designers with more opportunities to plan spaces that generate atmospheres that are conducive to human well-being.

The study explores neuroscientific correlates of architectural space by using eight neuro-environment attributes, derived from Zeisels' (2005) deep healing design principles, in order to measure effects on the human brain. The neuroscientific concepts of mood, ability to focus attention, and stress are those measured in this study.

Background

There is a growing interest among architects and neuroscientists to find out how the brain responds to architectural settings. The Academy of Neuroscience for Architecture (ANFA) has established a program where the profession of architecture has become a partner in developing the application of the expanding body of knowledge that has evolved within the neuroscience community (Eberhard 2005). Since the late 1990's, ANFA has organized workshops on healthcare facilities, sacred places, and on elementary schools where each workshop has resulted in the development of hypotheses, revolving around subjects such as sound, light levels, spatial competence, colour, visual functions, wayfinding, privacy and calming environments and their impact on humans.

Neuroscience is *the study of the brain and the mind* and architecture is *the profession of designing buildings and environments with consideration for their aesthetic effect* (Eberhard 2003). The term *neuroarchitecture* is an amalgamation of the two. Thirty-five years ago, social and psychological sciences were seen as a new frontier of knowledge that embraced design professions to expand their frontiers. Today, neurosciences embrace both design and social sciences as a new frontier to resolve answers and hypotheses that relate to environment-behaviour studies.

The way each and every one of us experiences architectural spaces affects how our body and brain connects to that space (Gall, in Eberhard, 2003, p. 4). As we constantly register environmental variables such as air temperatures, lighting, noise, odours, furniture and spatial comfort we build on our cognitive senses and develop our own perceptions and preferences for space (Eberhard, 2005).

As research between neuroscience and architecture aims at a greater understanding of architecture to enrich the human experience, those who design places for human use must work side by side with neuroscientists to find research-based knowledge that will

allow them to predict consequences of design decisions and provide a scientific basis for their design proposals. The idea is to collect data that can be useful for designers to create spaces that allow people to reach their full potential in whatever kind of space they live, work or play in (Whitelaw in Eberhard, 2003, p.5).

In order to explore this, the following two hypotheses have been set in place:

1. Peoples' moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit.

2. Setting the right mood for space users while conveying a positive atmosphere (good environment / energy in) will generate feelings of well-being and therefore less stress and adaptation (bad environment / energy out) to spaces they occupy.

A change in the office environment for the Society for Neurosciences (SfN) in Washington, D.C. is used as the subject of investigation in order to test these hypotheses. A survey was conducted on SfN employees in their offices situated on Dupont Circle. This initial survey was to find out how certain environmental characteristics affected their feelings about the work environment. A second survey was conducted with SfN employees in the new offices, six months after their move to 14th Street. Based on results from the first survey, the design of the new office location was intended to improve employee feelings about their work environment.

Theoretical Framework

Vischer's (2005) Environmental Comfort Model of User-Space Interaction: the comfort-productivity continuum, shown in Figure 5-1, suggests that a *good environment* provides *energy* for employees and will affect their work performance in a positive way. For the purpose of this study, the hypothesis that *energy in* (additional energy) will result in a *good mood* caused by *ability to focus attention*, has been added to this model.

Vischer's (2005) model also suggests that a *bad environment* signifies a *loss of energy* on the part of the employee. This signifies that the environment is not convenient

and fatigue or illness may result if the employee is required to expend energy adapting. For the purpose of this study, the hypothesis that *energy out* (energy loss) will result in a *bad mood* caused by *stress,* has been added to this model. This is the theoretical basis for hypothesizing that the neuroscience concepts of mood, ability to focus attention, and stress are directly related to the environment.

In his book *The Timeless Way of Building*, architect Christopher Alexander (1979) provides us with a powerful way of finding out just which building patterns are balanced and which ones are not. Certain patterns make us feel good because they help to make us whole and we feel more at one with ourselves in their presence. To measure the brain/mind response to experiences in architectural settings, Eberhard's (2007) approach is to provide what we feel as the scientific basis for the importance of design on our mental and physical well-being.

Zeisel's (2005) Brain Design Principles, as shown in Table 5-1, are used for this study. These were designed as profound and universal brain design principles applicable not only for environments for people with Alzheimer's disease to improve their state of mind, but also for people in other settings such as offices. These principles relate to basic elements of the space that help Alzheimer patients function and feel better in their living environments. If brain design principles help improve the lives of people living with Alzheimer's disease, they may also be supportive to others who have normal brain states (Zeisel 2006).

The neuroscience concepts of mood, ability to focus attention, and stress directly relate to the environment. They were selected because they can be measured behaviourally and respondents can provide reliable data on them. By measuring respondents' behaviours in regards to the eight brain design principles, the study shows how environmental features in the office affect mood, ability to focus attention and stress.

Table 5-2, Neuroscientific Correlates / Neuroscience Concepts, shows how each of the eight neuroscientific correlates are allocated to the neuroscientific concepts of mood, ability to focus attention and stress. Out of the eight neuroscientific correlates, four of them; sense of safety and security, awareness of outdoors and nature, support and comfort for

personal work needs as well as sense of pride and accomplishment are used as measures of mood. Three factors; understanding what is expected at work, wayfinding and feeling part of a cohesive organization are used as measures of ability to focus attention. And, five factors; sense of safety and security, ability to withdraw and unwind, awareness of outdoors and nature, support and comfort for personal work needs as well as feeling part of a cohesive organization are used as measures of stress.

METHODOLOGY

The research was conducted in three phases and involves fifty-eight staff members of the Society for Neuroscience (SfN) before and after their move to a new building. Founded in 1969, this world's largest organization of scientists and physicians has nearly 42,000 members in more than 90 countries and 130 chapters worldwide. Part of the mission of this non-profit organization is to advance the understanding of the brain and the nervous system by bringing scientists together to improve disease treatments and cures, to provide professional development activities, to promote public information and to inform legislators about recent scientific developments.

The first phase of the study took place in the pre-move office where the SfN occupied the 3rd, 5th and 7th floors of a 15- storey building in central Washington, D.C. The main entrance to the SfN offices was located on the fifth floor and the building's elevator core connected the three SfN office floors.

Fifty-eight employees responded to a digital neuro-environment assessment questionnaire (see Appendix 2), which could be filled out digitally or manually. The question '*How do the following items contribute?*' related to a list of questionnaire items as most likely to play a role in respondents' answers. The salient environmental characteristics in each of the eight categories were generated through expert observation prior to the study (see Appendix 2). Respondents were asked to rate selected environmental characteristics in terms of how these affected their experience working in the office, with a choice of responses: *A lot - A little - Not at all – Has opposite effect*. These data were then analysed to determine how each of the eight brain-based behaviours were affected, and these in turn

allowed us to assess the influence of the physical environment on established neuroscientific concepts of mood, ability to focus attention and stress.

The second phase of the study was conducted six months after the move to new premises, also in downtown Washington, D.C., where employees completed the same digital neuro-environment assessment questionnaire for a second time. As results from the first survey had been made available and used by the designers of the new offices, questionnaire items in the second survey were changed slightly to reflect features that were present in the new workspace but not in the pre-move offices (see Appendix 3). As for the pre-move survey, these changes were based on expert observation and discussion of design program objectives which can be seen in Figure 5-2, Plans Presenting Design Objectives for the New Office. These illustrate the design elements that were taken into consideration for designing the three floors at the new office.

These design objectives for the new office include goals relating to each of the eight neursoscientific correlates intended to make the new SfN offices more supportive of employees' ability to do their jobs, and in turn improve employees' mood, ability to focus attention and reduce work stress.

The five grey boxes highlighted in the diagram represent those that are primarily influenced by office-wide environmental attributes, meaning those that relate primarily to spaces which are common to everyone (such as corridors, staircase, coffee-bar, conference room, cafeteria …) and not limited to individual spaces such as closed, private offices.

The goal of this phase of the study was to compare the environment of the new offices with that of the old offices and to assess how – and how much – the new workspace contributed to brain activity. Employees again responded to the question *'How do the following items contribute*?' which related to a list of environmental characteristics judged to be correlated with brain behaviour.

The third phase of the study was conducted in the new office to collect data through on-site observation, photographs, behavioural mapping and group interviews. These data were collected nine months after the move into the new building.

Based on design program objectives, behavioural mapping was used to observe behaviour in the lunchroom on the 10th floor, in the huddle rooms on the 9th and 11th floors as well as in coffee-bars on the 9th and 11thfloors. The observer was positioned in the stairs that connect the three floors in order to observe activity on each floor for about five minutes at 15-minute intervals. Observations started at 11h45 a.m. and continued until 16h40 on the same day. Each area was observed 20 times during that period. On the same day, feedback sessions, in the form of group interviews, were recorded. Employees for the group interviews were selected according to their willingness to participate in the study and according to their time availability. Five groups of three to five employees were asked how they felt the new offices contributed to their satisfaction and ability to work. Following are the questions that were asked:

-"To what degree do you feel your particular workspace helps you in your work?"
-"Generally, how satisfied are you with the physical environment of your workspace?"
-"To what degree do you feel the physical environment of the SfN offices as a whole helps you in your work?"
-"Generally, how satisfied are you with the physical environment of the SfN offices?"

Results were used to interpret and understand survey responses and to aid in clarifying neuroscientific correlates. The goal was to confirm and validate ways in which SfN employees felt the move to the new offices improved their ability to do their work and if they were satisfied with the new offices.

During **analysis**, responses for both neuro-environment assessments (old and new office locations) were grouped into their corresponding eight neuroscientific correlates in order to identify which features of the workspace design contributed to employee feelings and behaviour in regards to mood, stress and work satisfaction. Survey items were rated on a scale of one to five representing how much each design feature contributed to each behavioural / brain category, where five means that the item contributes 'a lot', four contributes 'a little', two contributes 'not at all' and one means 'has opposite effect'. There is no three as this number represents the 'neutral' area between positive and negative values. Survey data were entered into Statistical Package for Social Sciences (SPSS) and

Statistical Analysis System (SAS) for analysis using Correlation Analysis, Analysis of Variance, and cross-tabulated tests of significance.

Results from the two neuro-environment assessments were used to create a correlation matrix to measure how brain activity responded to the built environment in the old and new offices. Testing allowed us to verify which environmental characteristics within the eight brain-based neuroscientific behaviours correlate most, or least, significantly with features of the office environment. Finally, the links connecting the eight neuroscientific correlates with the three neuroscience concepts of mood, ability to focus attention and stress were evaluated as a holistic way of measuring how users' brains respond to the built environment for work.

RESULTS

Neuro-environment assessment results from the first phase of the study are shown in Figure 5-3, SfN Phase 1 – Eight Variables. After establishing a high score of internal coherence for each of the eight categories, an average score was calculated based on the scale responses for each category. In descending order and on a scale of one to five, scale means of results show that awareness of outdoors was rated the highest at 3.97. Rated highest means that on average, the environmental characteristics in this category of neuroscientific correlates are the most strongly related to the category to which they were attributed – in other words, they are better 'predictors' of the brain design experience that they measure. Ability to withdraw was rated 3.93, support and comfort was rated 3.92, sense of pride was rated 3.78, safety and security was rated 3.54, understanding expectations was rated 3.38, wayfinding was rated 3.18 and feeling unified was rated 2.72.

Neuro-environment assessment results from the second phase of the study are shown in Table 5-3, Pre- and Post-Move Neuroscientific Correlates. In descending order and on a scale of one to five, results show that three of the eight neuroscientific correlates are more supportive of employees' ability to do their work in the new office location. These are: sense of safety and security (3.54, 4.0), wayfinding (3.18, 3.9) and feeling part of a cohesive organization (2.72, 3.8). Numbers on the left represent scale means of results for the old office and numbers on the right represent scale means of results for the new office.

These represent design decisions that were made for office-wide neuroscientific correlates, meaning those areas in the office that are widely used by most employees. These are also shown in Figure 5-2, Plans Presenting Design Objectives for the New Office, and were intended to better respond to user needs when designing the new office.

As shown in Table 5-3, Pre and Post Occupancy Neuroscientific Correlates, the five remaining neuroscientific correlates are rated lower in the new office than they are in the old office. These are: understanding what is expected in the work environment (3.38, 3.3); ability to withdraw from co-workers and unwind (3.93, 3.5); awareness of outdoors and nature (3.97, 3.8); support and comfort for personal and work needs (3.92, 3.6); and sense of pride and accomplishment (3.78, 3.5). Again, numbers on the left represent scale means of results for the old office and numbers on the right represent scale means of results for the new office.

Though there are declines in ratings of neuroscientific correlates that employees feel did not contribute as much in the new office as in the old office, results from Table 4-4, Pre- and Post-Move Work Contribution and Satisfaction Ratings, indicate that their overall satisfaction and feeling of support for work increased in the new location. Numbers on the left represent scale means of results for the old office and numbers on the right represent scale means of results for the new office.

In the Work Contribution column at the top left hand side, contribution to work (3.6, 3.9), SfN offices (3.5, 3.8) and personal workspace (3.7, 3.9) are rated higher for the new office. In the Satisfaction column at the bottom left hand side, satisfied with environment (3.6, 4.0), SfN offices (3.5, 4.1) and personal workspace (3.7, 3.8) are also rated higher for the new office. This means that based on pre-move ratings derived from the old office, design objectives that were set forth before moving to the new office were successful in creating a new office space that better responds to employees' work contribution and satisfaction.

Results from behavioural mapping in the third phase of the study indicate that employees no longer had to exit their main office and go to the building's main elevator in order to commute to other areas of the office space. In the new office, they made

continuous use of the central stair which communicates between the three floors. Observations showed that employees walked back and forth to the lunchroom (situated on the 10th floor between the 9th and 11th floors) and coffee areas (situated close to the central stairway that connects the three floors of the new SfN office location). The centralized stair, coffee bar, entry to service area, and just-in-time small conference rooms appear to facilitate wayfinding. When employees were in the lunchroom or coffee-bar areas, they engaged in conversation with other employees of the SfN. Results indicate that the new office encourages informal encounters and communication which facilitate 'feeling part of a unified cohesive organization'.

Results from behavioural mapping also indicate that neuroscientific correlates which are influenced by individual work-station attributes such as support and comfort for personal and work needs were improved in the new office. For example, office employees were able to close or open their office doors as needed and the sound of the new ventilation system veiled outlying sounds. Both of these represent an improvement for employees in the new office.

Results from group interviews in the third phase of the study support findings that several of the eight neuroscientific variables were improved in the new office space. For example: 'understanding expectations' was improved for employees due to policies and procedures being more regulated; 'ability to withdraw' was judged improved because the new space offered a good lunch room, where seating availability was plenty; wayfinding was considered improved because the central staircase now unites the three office floors; a better sense of pride was attributed to the new office having a more professional appearance; support and comfort for personal and work needs was considered better in some ways because the new office offers better lighting, more work space, has more storage and has glass walls that allow natural light. On the other hand, interview results indicate that employees feel that the old office was warmer, quieter and closer to a metro station. In the new office, employees work with their doors closed and the temperature is colder.

Below is a summary of both neuro-environment assessments and observation sessions highlighting items for each of the eight neuroscientific correlates, showing how each of the eight neuroscientific principles were assessed by SfN employees in relation to the old and new workspace.

1. Feeling safe, secure and free: Employees feel that sensor cards limit entry, and that the guard and sign-in procedures make them feel safer in the new office than in the old office.

2. Community expectations: Communication devices such as bulletin boards were not yet placed in the new office when employees participated in the research. They also had not had the time to get accustomed to the new office environment to be able to qualify spaces as formal or informal communication places. Nonetheless, observation data shows that employees from the 9th, 10th and 11th floors of the new office meet to have lunch on the 10th floor.

3. Being able to withdraw on occasion and unwind: Employees rated the old office higher in terms of being able to withdraw and unwind as they were close to a park and coffee shops. Employees had not yet had the time to discover these places in the new office location. Though the central lunchroom and coffee bar located on each floor serve as places to eat or get beverages, data from observations show that these places do not serve as areas where employees can feel removed from their work environment to unwind. When referring to office privacy, data from observations show that the opening and closing of doors provide the choice for privacy but the opaque glass walls from floor to ceiling do not necessarily reflect that. These however provide more daylight to interior offices that do not have windows to the exterior.

4. Knowing where you are going and enjoying getting there: Analysis from questionnaire and observation data confirm that the layout of the new offices has been successful in improving the ease of employee wayfinding in the new office. This is primarily due to the similarity of layout between floors, the central staircase, the common areas on the middle floor and the addition of signage.

5. Contact with outdoors / nature: For items such as *views/daylight, office windows and plants*, employees rated these higher in the old office than in the new office. The large windows, the courtyard and the views towards the exterior seem to provide more contact with the outdoors at the old office. In the new office all the rooms bordering the periphery of the building have views to the exterior, the lunchroom is situated on an exterior window wall as prescribed and initial design objectives have been met. On the other hand, employees feel that the old office better suited their needs concerning contact with outdoors and nature.

6. Feeling supported and comfortable at work: Survey results show that there is a mixed assessment of how items contribute to work support and comfort. On the other hand, observations indicate that employees made use of the support services around the stairway at each floor. This was to either eat in the lunchroom, to get a beverage at the coffee counter or to go to the storage / photocopy room.

7. Celebrating achievement: Based on employee feedback at the old office where they felt they had nothing to celebrate their achievements, items such as the *display wall at the front entrance* and the *prominent events calendar* were planned for the new office. Observation shows that though employees had time to get accustomed to their personal workspace, they may need more time to make use of the display wall at the front entrance which is quite prominent and stands out.

8. Not having to struggle to understand your surroundings: Survey data and observations show that cohesiveness of organization is assessed by users in terms of *office wall surfaces and sizes, the clearly evident hierarchy of offices, the clear centrality of the middle floor common spaces, the highly visual centralized connecting stair,* as well as *the similar office layouts on all three floors*.

Results from these data confirm that design elements, based on neuroscientific attributes that were initially put in place to support employees' ability to do their jobs in the new office, were helpful in certain areas. According to user ratings, three out of the eight neuroscientific brain-design correlates are more supportive in the new office design than they were in the old office design. These represent office-wide environmental attributes

rather than individual work-station attributes. Overall employee ratings for work contribution and satisfaction are higher for the new office.

The Correlation Matrix shown in Table 5-5 indicates that support and comfort for personal work needs correlates highly with several other neuroscientific correlates in both the old and the new office. Understanding expectations, ability to withdraw and unwind, awareness of outdoors and nature, as well as sense of pride and accomplishment are the factors that most affect employees' sense of being supported at work. The correlation coefficients for these factors in both the old and new offices are significant at over 0.6.

Results show that fourteen out of sixteen items at the old office and sixteen out of eighteen items at the new office are significantly correlated with support and comfort for personal work needs. The most significant items at both locations are *windows and natural light in offices* and *ability to display personal objects in private office*.

The Correlation Matrix also indicates that feeling part of a cohesive organization correlates the least with other items in both old and new offices. Ability to withdraw and unwind, wayfinding, as well as support and comfort for personal work needs are the factors that contribute least to users' feeling part of a cohesive organization. The correlation coefficients for these factors are below 0.3 in the old office. On the other hand, ratings indicate that wayfinding and support for personal work needs are much improved in the new office.

One out of five items at the old office and six out of six items at the new office are significantly correlated with feeling part of a cohesive organization. The most significant item at the old office is *main entry lobby on 5th floor*. The two most significant items at the new office are *central stair connect three office floors* and *main lobby on 10th floor*.

In order to relate these findings to neuroscientific categories of brain behaviour, the average ratings for each neuroscientific correlate were calculated for both offices and were inserted in Table 5-6, Space Users' Responses to the Environment. The ratings for Mood, Ability to Focus Attention and Stress, were placed on the left hand side for the old office and on the right hand side for the new office.

Table 5-6, Space Users' Responses to the Environment, indicates the means for those scales predictive of the eight neuroscientific correlates and how they are linked to the three neuroscience concepts of mood, ability to focus attention and stress. Results show ratings were generally higher for the new office. Support and comfort for personal work needs was rated highest (4,10) for the new office and corresponds to mood and stress. This could mean that this neuroscientific correlate may be more supportive of employees' ability to do their jobs, and in turn improve employees' mood and reduce their work stress levels. Feeling part of a cohesive organization was rated lowest for both the old (1,63) and new (2,80) offices and corresponds to ability to focus attention and stress. Wayfinding, which relates to ability to focus attention, was rated relatively the same for both old and new offices, being lower by 0.04 in the new office.

DISCUSSION

The neuroscience and architecture evidence found in this study suggest ways in which environmental characteristics of architectural spaces impact the brain. Findings provide designers with information that can be used prior to the space planning process, so that they may design spaces that are geared toward human well-being.

The results suggest that neuroscience / human-behaviour / built-environment interrelationships can be regarded as means to better meet human needs. Environmental characteristics shape the patterns of people's behaviour (Pilatowicz 1995), impact on the human brain (Zeisel 2006) and affect people's mood, ability to focus attention and stress level.

Results support the hypothesis that people's moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit. In comparing ratings gathered from occupants in the pre- and post-move phases of the study, three out of eight neuro-environment factors, which represent office-wide environmental attributes, were rated higher for the new office. Five out of eight neuro-environment factors, which represent individual work-station attributes, were rated lower for the new office. Due to their recent arrival in the new offices, employees had not yet found interesting coffee shops as places of retreat to unwind, or a favourite nearby park to enjoy

nature and the outdoors. Giving time for employees to get accustomed to their new environment may provide an opportunity for a more positive impact on responses.

Results also support the hypothesis that setting the right mood for space users while conveying a positive atmosphere (good environment / energy-in) will generate feelings of well-being and therefore less stress and adaptation (bad environment / energy-out) to spaces they occupy. For example, data analysed from the neuro-environment assessment of the old office guided the design of the three floor spaces in the new office. During group interviews many participants mentioned that the space in the new office was cold, that they felt drafts of air and that they had to bring extra sweaters to keep warm. Some felt that the huddle rooms were great for meetings but these did not offer a space for someone to retreat and unwind. One person felt that she had 'lost her own space' when moving to the new office. These comments show that employees are now adapting to a new office that does not necessarily respond to the habits they had in the old office.

On the other hand, results from both behavioural mapping and from the neuro-environment assessments show that the *central staircase connecting the three office floors*, *same type of furniture for all employees* and *more storage space and more work surface* are all improvements in the new office. Some employees feel that they have a sense of pride in the new office and that lighting conditions are better for them to see. These conditions may help them feel that they are in a better, unified cohesive organization than in the old office.

Figure 5-4, Design Elements Shown to be Affected by Neuroscientific Correlates, shows examples of design elements in the new location that most contribute to brain-specific design principles assessed in the present study.

Sense of safety and security is affected by such design elements as *electronic key card to enter SfN offices*, *security guard at building entrance*, as well as *guests being required to sign in and out*. These design elements help improve employees' feelings of safety and security in their office environment and also reduce stress and improve mood for employees since sense of safety and security refers to mood and stress (see Table 5-2, Neuroscientific Correlates / Neuroscience Concept).

Wayfinding is affected by such design elements as the *central staircase unifying three floors*, *plaques with ID of office occupants /signs /directories*, *similar hallway and office layouts* and *windows to the outside*. These design elements improve employees' ability to find their way through the office space and may also help them to better focus since wayfinding refers to ability to focus attention (see Table 5-2, Neuroscientific Correlates / Neuroscience Concept).

And, feeling part of a unified cohesive organization is affected by design elements as *main entry lobby on the 10th floor*, *standardized office furniture materials and quality* as well as *standardized office sizes*. These design elements help employees feel that they are part of a cohesive organization. They may also help employees focus and feel less stressed since feeling part of a cohesive organization refers to ability to focus attention and stress (see Table 5-2, Neuroscientific Correlates / Neuroscience Concept).

Table 5-6, Space Users' Responses to the Environment, indicates that support and comfort for personal work needs as well as sense of pride and accomplishment are rated higher in the new office. Since these refer to mood it may be concluded that the improved space in the new office resulted in more positive energy for users.

Study results confirm that environmental characteristics shape patterns of people's behaviour (Pilatowicz 1995) and impact the human brain. Using environment / behaviour / neuroscience assessment tools can help to determine how the environment performs with specific focus on neuroscientific responses such as mood, ability to focus attention, and stress. It is becoming more possible to design spaces that actively influence brain states that contribute to productivity and quality of work life (Zeisel 2006).

Overall study results demonstrate that:

1. Data derived from the pre-move survey was useful in designing a better layout of the three floor spaces that were used for the new office.

2. As shown in Table 5-3, Pre- and Post-Move Neuroscientific Correlates, sense of safety and security, wayfinding and feeling part of a unified cohesive organization

are the three neuroscientific correlates that are rated highest in the new office. This may be due to the central staircase that connects the three floors in the new building. Sense of safety and security relates to mood and stress in Table 5.6, Space Users' Responses to the Environment. Wayfinding relates to ability to focus attention. And, feeling part of a cohesive organization relates to ability to focus attention and stress.

3. Results from pre- and post-move data analysis also show that employees' overall satisfaction and feelings of support for work increased in the new office, as shown in Table 5-4, Pre- and Post-Move Work Contribution and Satisfaction Ratings.

4. Intangible aspects of architectural spaces affect human well-being and using neuroscientific correlates to access users' experiential material has provided empirical confirmation of some of the ways in which this relationship works in offices.

Future research on neuro-environment factors should aim at letting individuals express their feelings on how environmental characteristics affect their frame of mind – that is, their mood, their ability to focus attention and their stress level. The resulting data can be combined with other neuroscientific research to create spaces for user needs based on subjective feelings that are very much in touch with reality (Alexander, 1979). In considering peoples' feelings as a basis from which to design environments Alexander (1979) explains that:

> ''*It is easy to dismiss feelings as 'subjective' and 'unreliable,' and therefore not a reasonable basis for any form of scientific agreement…However, in the domain of patterns, where people seem to agree 90, 95, even 99 percent of the time, we may treat this agreement as an extraordinary, almost shattering, discovery, about the solidity of human feelings, and we may certainly use it as scientific*'' (p. 294).

The Model of Experiential Responses to space, as shown in Figure 4-1, illustrates that architectural spaces are composed of several environmental characteristics that generate intangible atmospheres which affect user moods and shape human experience.

These responses can then be expressed as feelings of satisfaction and well-being or as feelings of discomfort which can lead to illness. Furthermore, Vischer's (2005) Environmental Comfort Model of User-Space Interaction, as shown in Figure 5-1, illustrates that a good environment provides energy for employees and will affect their performance in a positive way and will result in good mood caused by the ability to focus attention. Vischer's (2005) model also shows that a bad environment signifies a loss of energy on the part of the employee and that fatigue or illness may result if the employee requires too much adaptation. This will result in bad mood caused by stress.

For example, in the Neuro-Environment Assessment Questionnaire – Pre- and Post-Move (Appendixes 2 and 3), questionnaire items such as *windows and natural light in individual offices*, *manually controlled office window blinds* and *opportunity to display personal objects in private offices* refer to the neuroscientific correlate of support and comfort for personal work needs. This correlate is linked to the neuroscience concepts of mood and stress.

Allowing employees to have access to natural light, to control their blinds and to be able to personalize their office by displaying personal objects, may render them more at ease in their work space and they may be less stressed and in a better mood. This is an example that proves the hypothesis that peoples' moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit.

Similarly, in the Neuro-Environment Assessment Questionnaire – Pre- and Post-Move (Appendixes 2 and 3), questionnaire items such as *windows in private offices*, *interior plants* and *access to views or daylight* refer to the neuroscientfic correlate of awareness of outdoors and nature. This correlate is also linked to the neuroscience concepts of mood and stress. It can be said that the design of the new office supports the hypothesis that setting the right mood for space users while conveying a positive atmosphere (good environment / energy in) will generate feelings of well-being and therefore less stress and adaptation (bad environment / energy out) to spaces they occupy.

The research reported here on neuroscientific correlates of architectural space has demonstrated the viability of Zeisel's (2006) deep healing design principles as applied to

the work environment. It has also shown to be relevant because it has further expanded Côté's (in progress) and Vischer's (2005) models by proving that mood, ability to focus attention and stress are directly related to the environment. It has demonstrated that the new field of neuroscience and architecture can be used to generate knowledge on how architectural spaces influence human well-being. It also increases the awareness that understanding neuroscience / human-behaviour / built-environment interrelationships can offer solutions to better satisfy human needs. Research results from the first survey provided insight used to design the new office. Survey results from the second assessment allowed us to see if design objectives had been met. Survey findings were useful for space planners using neuroscientific data to formulate design adjustments that geared towards making employees feel comfortable in the spaces within which they work.

CONCLUSIONS

The research reported in this article contributes to the knowledge base of the interior design body of knowledge through the career cycle and health / safety / welfare framework (Guérin and Martin 2004) and reinforces the value of discourse in design studies. It increases awareness that neuroscience / human-behaviour / built-environment interrelationships can be used to find solutions to meeting human needs. Environmental characteristics impact the human brain and affect people's mood, ability to focus attention and stress level (Zeisel 2006).

The environment is not only designed to meet specific user needs but also affects brain state and quality of life (Zeisel 2006). Therefore, there is value in identifying design features in neuroscientific terms and this can be an important new tool for design. The study demonstrates that knowledge derived from measuring the effects of certain design features on brain behaviour in terms of mood, stress and sense of work satisfaction can make an important contribution to finding out what it is about the environment that makes space users feel the way they do. Study results offer directions for further research whereby participants' neuroscientific responses to environmental attributes can lead to even more precise measurement of human experiential responses to space. The research indicates that the study of neuroscience and architecture can lead to a better understanding of how and why people feel the way they do in the spaces they occupy.

Combining design research with neuroscience has tremendous value for design professionals as it is through research findings that not only will professionals be able to study human behaviour in relation to the environment but they will also be able to know how the mind is affected and shaped by the physical environment. Neuroscientific research offers new tools to aid in the design process that can help designers understand how individuals' brains perceive and respond to intangibles in the architectural environment so as to improve design's impact on human development and well-being.

Neuroscience studies have made it possible to know more about how and why humans experience their environment (Eberhard 2003, Eberhard 2005). As a result, successful design of work environments can be measured in terms of increase to users' positive energy and better employee performance outcomes. Results of the study help explain how multiple environmental characteristics of architectural spaces are perceived by our sensory system (Eberhard 2005).

This study shows that we were successfully able to test the eight deep healing design principles in two office environments. We were able to use them to assess the neuroscientific, or brain, impact of features of architectural space. This study proves that these design principles, normally used for Alzheimer patients, also apply to work and other built environments (Zeisel, 2006). If designing healthy spaces for people that are ill has potential to make them well, it certainly can have a positive effect on space users who are in good health. For example, this study shows that individual work-station attributes helped employees find support and comfort for personal and work needs. Further research may investigate more details such as finding out if employees may eventually feel pride and self-accomplishment within their work environment. Giving them time to get accustomed to their new office may reveal new data as to how they feel environmental characteristics affect their mood, ability to focus attention and stress once they've gotten accustomed to their new workplace.

Providing designers with research findings prior to the design process enables them to design spaces not only in response to user needs but also geared towards their long-term well-being. Brain design principles (Zeisel 2006) were used as a basis for this study and

provided a strategy for evaluating the old and new office environments. Results indicate that there was an increase in work contribution and satisfaction in the new office primarily attributable to office-wide environmental attributes. This proves that the environment does have an effect on our brains and on who we are as individuals (Gage, in Jarmusch 2003).

Kant (in Merleau-Ponty 2004) tried to draw a line between space as the form of external experience and the things given within that experience. Alexander (1979) refers to atmospheres, and not necessarily the beauty of a building, and that it is people that make the atmosphere possible. For example, he refers to a window place, and not the window itself, where a person comes to life. Architectural spaces, composed of multiple environmental characteristics, create atmospheres that do impact people's mood and satisfaction (Côté, in progress). Using the offices of the Society for Neuroscience as a case study has shown that a new way of accessing human experiential material is possible, and that it can be used to generate additional knowledge on how architectural spaces influence human well-being.

As humans we all carry an invisible umbrella that we open wide or narrow depending on our needs for protection. Just like rain can fall heavily or lightly, so do the hazards we need to be protected from. Like a shell that protects hatchlings as they are growing, our umbrella acts as a cocoon to protect us from pollution, noise, crowds, … it protects us from environmental characteristics that can negatively impact our brain, and in turn our long-term well-being. We are in an era of inter-disciplinarity whereby professionals from varying fields must gather and share information so as to broaden knowledge bases so that design decisions are geared toward the protection and well-being of space users.

LIST OF TABLES

TABLES

BRAIN DESIGN PRINCIPLES			
1	Sense of safety & security	5	Awareness of outdoors and nature
2	Understanding what is expected at work	6	Support and comfort for personal work needs
3	Ability to withdraw & unwind	7	Sense of pride and accomplishment
4	Wayfinding	8	Feeling part of a cohesive organization

Table 5-1 Brain Design Principles (Zeisel 2006)

NEUROSCIENTIFIC CORRELATES / NEUROSCIENCE CONCEPTS				
Neuroscientific Correlates		**Neuroscience Concepts**		
		Mood	**Ability to Focus Attention**	**Stress**
1	Sense of safety & security	X		X
2	Understanding what is expected at work		X	
3	Ability to withdraw & unwind			X
4	Wayfinding		X	
5	Awareness of outdoors and nature	X		X
6	Support and comfort for personal work needs	X		X
7	Sense of pride and accomplishment	X		
8	Feeling part of a cohesive organization		X	X

Table 5-2 Neuroscientific Correlates / Neuroscience Concepts

Neuroscientific Correlates		RATING	
		Old Office	New Office
		Means	Means
1	**Sense of safety and security**	3.54	**4.0**
2	**Wayfinding**	3.18	**3.9**
3	**Feeling part of a cohesive organization**	2.72	**3.8**
4	Outdoor awareness	**3.97**	3.8
5	Ability to unwind	**3.93**	3.5
6	Understanding expectations	**3.38**	3.3
7	Comfort and support	**3.92**	3.6
8	Sense of pride and accomplishment	**3.78**	3.5

Table 5-3 Pre- and Post-Move Neuroscientific Correlates

FACTORS		RATING	
		Old Office	New Office
Work contribution	Contribution to work	3.6	3.9
	SFN offices	3.5	3.8
	Personal workspace	3.7	3.9
Satisfaction	Satisfied with environment	3.6	4.0
	SfN offices	3.5	4.1
	Personal workspace	3.7	3.8

Table 5-4 Pre- and Post-Move Work Contribution and Satisfaction Ratings

Old Office - Correlation Matrix

Neuroscientific Correlates	1. Sense of safety & security	2. Understanding what is expected at work	3. Ability to withdraw & unwind	4. Wayfinding	5. Awareness of outdoors and nature	6. Support and comfort for personal work needs	7. Sense of pride and accomplishment	8. Feeling part of a cohesive organization	Totals above the 0.3 cut off	Addition of scores that are above the 0.3 cut off	In descending order of significance (1=most and 8= least significant)
1. Sense of safety&security	1.000	0.511	0.343	0.421	0.337	0.535	0.562	0.331	7/7	3.04	6
2. Understanding what is expected at work	0.511	1.000	0.453	0.506	0.464	0.602	0.549	0.436	7/7	3.52	3
3. Ability to withdraw & unwind	0.343	0.453	1.000	0.584	0.444	0.642	0.435	0.276	6/7	2.90	7
4. Wayfinding	0.421	0.506	0.584	1.000	0.333	0.612	0.594	0.279	6/7	3.05	4
5. Awareness of outdoors and nature	0.337	0.464	0.444	0.333	1.000	0.611	0.430	0.419	7/7	3.04	5
6. Support and comfort for personal work needs	0.535	0.602	0.642	0.612	0.611	1.000	0.622	0.270	6/7	3.62	2
7. Sense of pride and accomplishment	0.562	0.549	0.435	0.594	0.430	0.622	1.000	0.443	7/7	3.64	1
8. Feeling part of a cohesive organization	0.331	0.436	0.276	0.279	0.419	0.270	0.443	1.000	4/7	1.63	8

New Office - Correlation Matrix

Neuroscientific Correlates	1. Sense of safety & security	2. Understanding what is expected at work	3. Ability to withdraw & unwind	4. Wayfinding	5. Awareness of outdoors and nature	6. Support and comfort for personal work needs	7. Sense of pride and accomplishment	8. Feeling part of a cohesive organization	Totals above the 0.3 cut off	Addition of scores that are above the 0,3 cut off	In descending order of significance (1=most and 8= least significant)
1. Sense of safety & security	1.000	0.503	0.370	0.460	0.493	0.595	0.544	0.430	7/7	3.395	5
2. Understanding what is expected at work	0.503	1.000	0.535	0.430	0.499	0.632	0.583	0.351	7/7	3.530	4
3. Ability to withdraw & unwind	0.370	0.535	1.000	0.391	0.543	0.662	0.522	0.300	7/7	3.230	6
4. Wayfinding	0.460	0.430	0.391	1.000	0.314	0.485	0.506	0.419	7/7	3.005	7
5. Awareness of outdoors and nature	0.493	0.499	0.543	0.314	1.000	0.675	0.589	0.444	7/7	3.557	3
6. Support and comfort for personal work needs	0.595	0.632	0.662	0.485	0.675	1.000	0.673	0.378	7/7	4.100	1
7. Sense of pride and accomplishment	0.544	0.583	0.522	0.506	0.589	0.673	1.000	0.481	7/7	3.898	2
8. Feeling part of a cohesive organization	0.430	0.351	0.300	0.419	0.444	0.378	0.481	1.000	7/7	2.803	8

Table 5-5 Correlation Matrix

SPACE USERS' RESPONSES TO THE ENVIRONMENT							
Neuroscientific Correlates		Neuroscience Concepts					
		Mood		Ability to Focus Attention		Stress	
		Old office	New Office	Old office	New Office	Old office	New Office
1	Sense of safety & security	3.04	3.40			3.04	3.40
2	Understanding what is expected at work			3.52	3.53		
3	Ability to withdraw & unwind					2.90	3.23
4	Wayfinding			3.05	3.00		
5	Awareness of outdoors and nature	3.04	3.56			3.04	3.56
6	Support and comfort for personal work needs	3.62	4.10			3.62	4.10
7	Sense of pride and accomplishment	3.64	3.90				
8	Feeling part of a cohesive organization			1.63	2.80	1.63	2.80

Table 5-6 Space Users' Responses to the Environment

LIST OF FIGURES

FIGURES

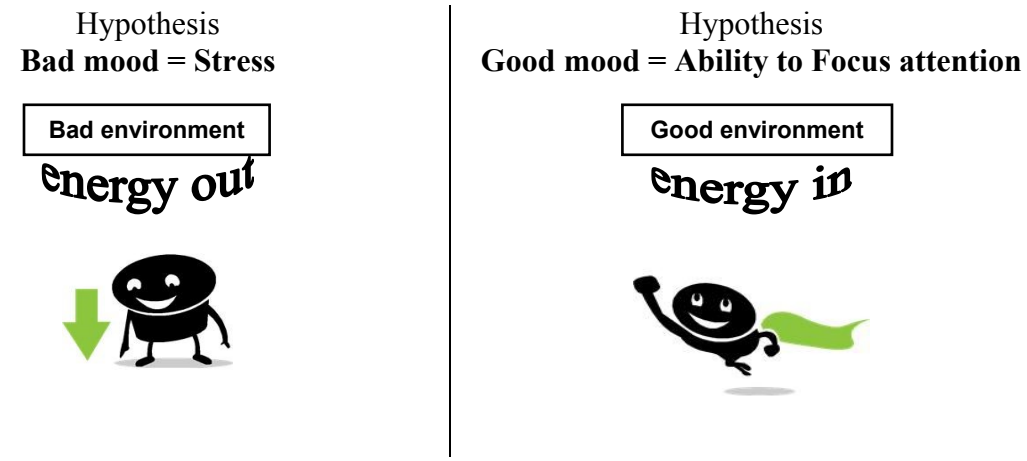


Figure 5-1 Environmental Comfort Model of User-Space Interaction: the comfort-productivity continuum (Vischer 2005)

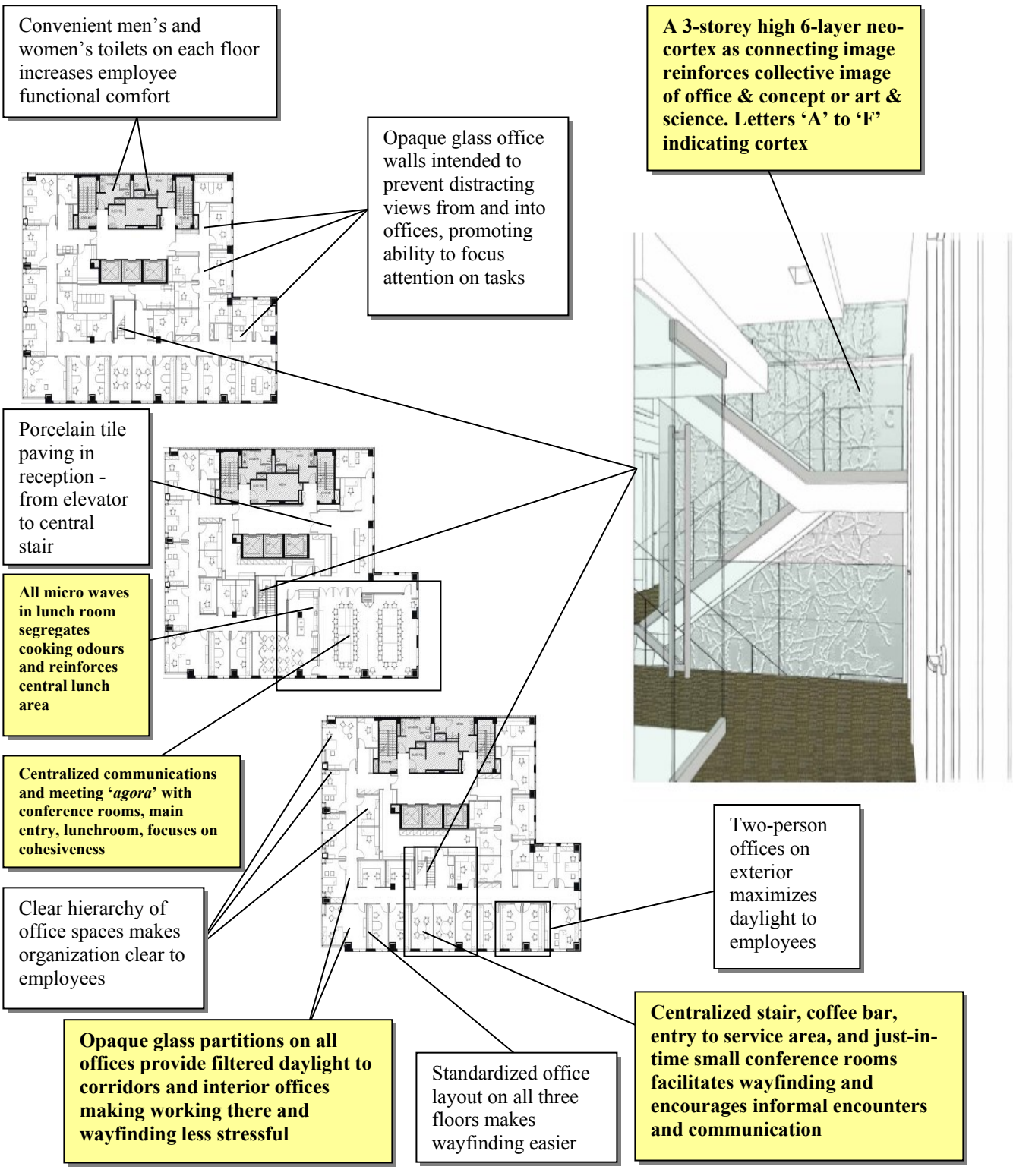
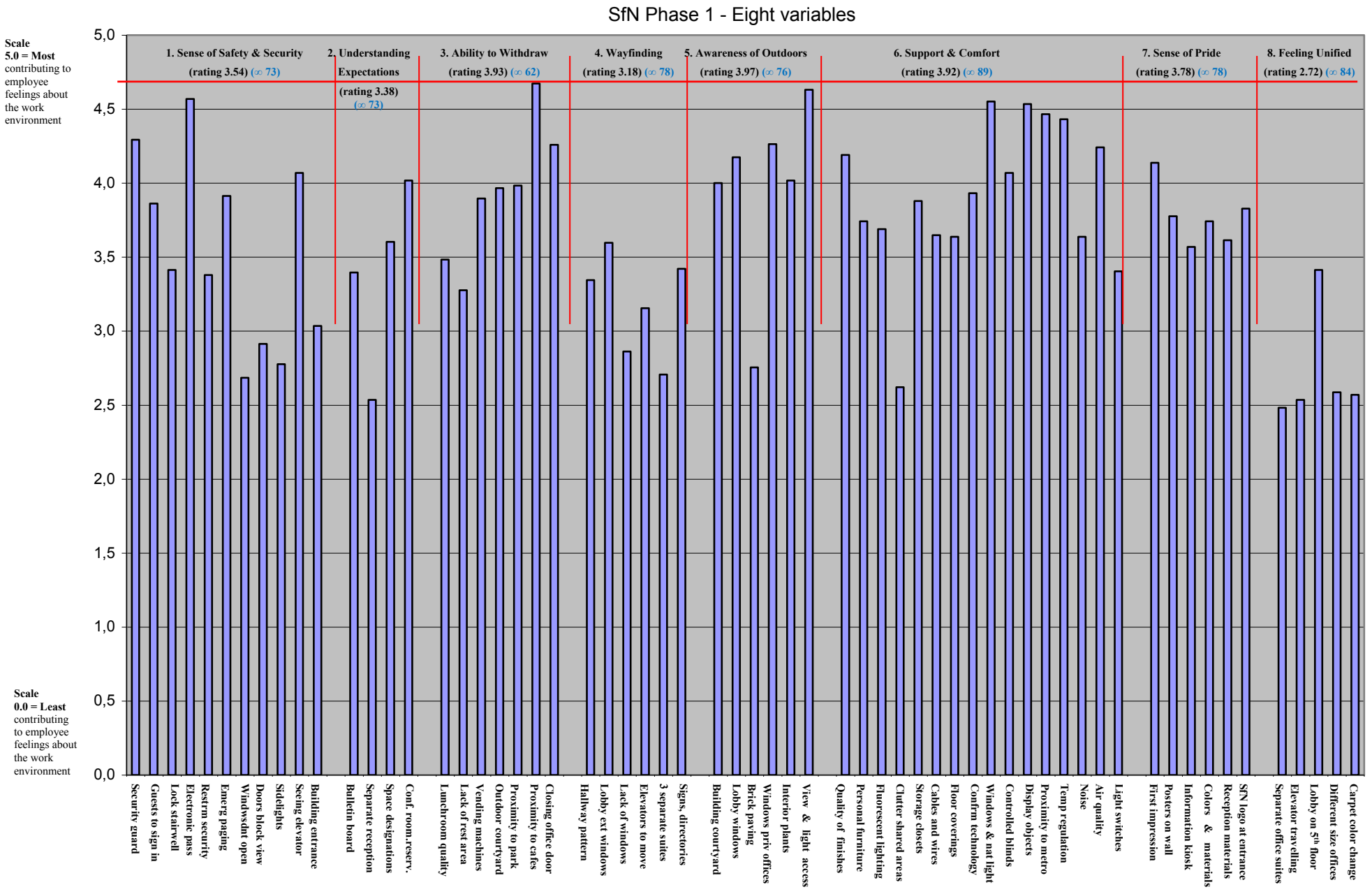


Figure 5-2 Plans Presenting Design Objectives for the New Office
(Zeisel 2005)

Figure 5-3


SfN Phase 1 - Eight variables
Scale
5.0 = Most
contributing to
employee
feelings about
the work
environment
Scale
0.0 = Least
contributing
to employee
feelings about
the work
environment
5,0
4,5
4,0
3,5
3,0
2,5
2,0
1,5
1,0
0,5
0,0
1. Sense of Safety & Security
(rating 3.54) (∞ 73)
2. Understanding
Expectations
(rating 3.38)
(∞ 73)
3. Ability to Withdraw
(rating 3.93) (∞ 62)
4. Wayfinding
(rating 3.18) (∞ 78)
5. Awareness of Outdoors
(rating 3.97) (∞ 76)
6. Support & Comfort
(rating 3.92) (∞ 89)
7. Sense of Pride
(rating 3.78) (∞ 78)
8. Feeling Unified
(rating 2.72) (∞ 84)
Security guard
Guests to sign in
Lock stairwell
Electronic pass
Restrm security
Emerg paging
Windwsdnt open
Doors block view
Sidelights
Seeing elevator
Building entrance
Bulletin board
Separate reception
Space designations
Conf. room.reserv.
Lunchroom quality
Lack of rest area
Vending machines
Outdoor courtyard
Proximity to park
Proximity to cafes
Closing office door
Hallway pattern
Lobby ext windows
Lack of windows
Elevators to move
3 separate suites
Signs, directories
Building courtyard
Lobby windows
Brick paving
Windows priv offices
Interior plants
View & light access
Quality of finishes
Personal furniture
Fluorescent lighting
Clutter shared areas
Storage closets
Cables and wires
Floor coverings
Confirm technology
Windows & nat light
Controlled blinds
Display objects
Proximity to metro
Temp regulation
Noise
Air quality
Light switches
First impression
Posters on wall
Information kiosk
Colors & materials
Reception materials
SfN logo at entrance
Separate office suites
Elevator traveling
Lobby on 5th floor
Different size offices
Carpet color change

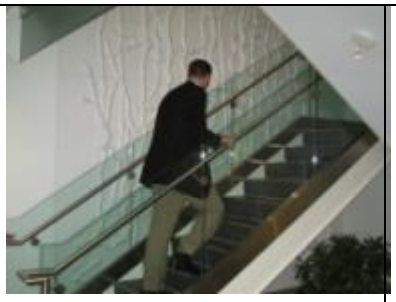
		
Sense of safety and security Electronic key card to enter SfN offices	**Wayfinding** Central staircase unifying three floors	**Feeling part of a unified cohesive organization** Main entry lobby on the 10th floor

Figure 5-4 Design Elements Shown to be Affected by Neuroscientific Correlates

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CHAPTER 6 – ARTICLE 3

TITLE

TOWARDS DEFINING THE INTANGIBLE ASPECTS
OF ARCHITECTURAL SPACES:
Integrating Qualitative and Quantitative Research

AUTHOR

Odette Côté

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BIOGRAPHICAL DETAILS

Odette Côté has both a college and university degree in interior design and has been practicing in this field for the last thirty years. She also has a bachelors and masters degree of architecture from the University of Montréal and is performing research to find out what intangible aspects of architectural spaces enhance human well-being. She has taught interior design for twenty years at college and university levels, was department coordinator of the Interior Design program at Cégep Saint-Jean-sur-Richelieu in the province of Québec, Canada and is now Faculty Dean for Social Sciences, Commerce, Arts & Letters at Vanier College in Montréal also in the province of Québec, Canada.

ABSTRACT

This article reports on a study that uses a qualitative and a quantitative method to discover something as complex as intangibles of experience. It uses both approaches in order to demonstrate how intangible aspects of architectural spaces influence human well-being. The goal is to increase awareness of how interior spaces impact human well-being and to show how architecture can be a solution to satisfy space users' needs.

In the first study a qualitative approach is explored through narrative inquiry in order to identify intangible aspects of residential and office spaces that affect human well-being. In the second study a quantitative approach is applied to collect and analyse empirical data to provide more detailed knowledge on how architectural spaces influence brain behaviour. Neuroscience and environment / behaviour concepts are used where eight brain-based neuroscientific correlates (Zeisel 2006) are investigated. Fifty-eight office employees responded to neuro-environment assessments in the form of user surveys before and after moving to a new location to see how certain environmental characteristics contributed towards their performance and well-being in both office environments.

Results from the narrative inquiry show that 48 environmental characteristics are interpreted as being intangible aspects of architectural spaces that influence human well-being. A discussion is built around the Model of Human Experiential Responses to Space which identifies environmental characteristics that enhance occupant well-being. In the second study neuroscientific outcomes reveal that the environment can affect human moods, focus of attention and stress levels and may also heighten task performance.

The integration of both research approaches help understand what makes people feel the way they do in architectural spaces. It reveals that people's moods may be affected similarly in residential or office space settings and that a good environment that energizes employees will affect their work performance in a positive way (Vischer 2005).

KEY WORDS: Architectural Spaces, Intangible Aspects, Human Well-Being, Environmental Psychology, Neuroscientific Correlates, Narrative Inquiry, Survey Research.

INTRODUCTION

Interior spaces have evolved over time but the impact of their environmental characteristics on space users has often been ignored. For years interiors have been shaped by the play of spatial arrangements but little is known about intangible aspects of architectural spaces and their effects on human well-being. Architectural spaces are composed of several environmental characteristics that together create the intangible, the mystery, the emotion, the magic… of interior spaces. This study analyses how atmosphere is created by multiple environmental characteristics in architectural spaces and how space users are affected using subjective accounts and objective neuroscientific measures in order to get a better understanding of this complex relationship.

Rogers (2004) states that:

> The interior environment is one that is easily changed to meet changing needs and interests and therefore mirrors rather accurately an individual, a people, or a culture. An interior environment is a fugitive, changing and fragile environment as man, himself, is fugitive, changing, and fragile. (p. V)

This research uses a qualitative and a quantitative approach to explore some of the complex relationships between architectural spaces and their effects on humans. Integrating these two approaches in order to measure intangible aspects of architectural spaces is innovative and important because both methods complement each other. Quantitative data can be used to flesh out and expand the results of qualitative data analysis.

This study begins with narrative inquiry as a quantitative approach in order to capture subjective material and continues with a quantitative approach using survey research through neuroarchitecture in order to solidify findings with scientific knowledge.

QUALITATIVE APPROACH USING NARRATIVE INQUIRY

Spaces may be regarded in terms of dynamic interactions and interrelations (Pallasmaa 2005, p. 64) where well-being becomes an essential component for human activity and refers to optimal psychological functioning and experience (Ryan and Deci 2001). In order to satisfy user needs, it is imperative that professionals gather all pertinent

data which can be used to design spaces for human well-being. The participation of space users, who best know what their needs are, can guide the process of growth in an environment and help to shape it (Alexander 1975). And, the best way to know what space users' needs are, is to ask them (Zeisel 2006).

Professional practice-based disciplines such as medicine, health care, law, education, and businesses are using narratives as a means of examining the intangible, interpersonal side of practice in order to get at subjective material at a given moment and time (Elkins 1996; Remen 1991; Cole 1997; Bliss and Mazur 1998; Lester, Piore et al. 1998; Danko 2000). Narrative inquiry is an interdisciplinary research method that allows for people's realities to be constructed through the narration of their stories. Genuine information, derived directly from the narrator's story, can be authenticated where both the author and the narrator assure and validate that what has been written is well interpreted as the 'truth' of what has been said (Clandinin and Connelly 2000).

In the context of this study, narrative inquiry is used to identify intangible aspects of architectural spaces that enhance human well-being and to find out how these can enhance a person's mood, satisfaction and long-term well-being. Due to the collaborative experience that it entails, both the voices of the narrator and the researcher are heard (Marshall and Rossman 1999). This method is used because it adds a great deal to '*authentic research*' as the information comes directly from the narrator's story (Connelly and Clandinin 1990).

QUANTITATIVE APPROACH USING NEUROSCIENCE AND ARCHITECTURE

The field of neuroscience and architecture, known as neuroarchitecture, is the result of two disciplines merging in order to acquire a greater understanding of architecture to enrich the human experience. Efforts to understand the relationship between the brain and the built environment has encouraged the collaboration of architects and scientists to study how the human brain perceives and responds to cues from architecture. Those who design places for human use may consider working side by side with neuroscientists to find research-based knowledge that will allow them to predict consequences of design decisions and use these to support their design proposals.

The goals are to explore how the human brain can be impacted by architectural space by measuring neuroscientific activity relative to spatial qualities, to determine why humans perceive and respond to the built environment the way they do, and to provide data on human brain processes for designers to better design buildings. Data provided by neuroscientific research may be used to generate knowledge on how environmental characteristics of architectural spaces influence human well-being.

According to Csikszentmihalyi and Rochberg-Halton (2002) social scientists have neglected a full investigation of the relationship between people, objects and their surroundings, therefore using neuroarchitecture as a base from which to access human experiential material can be useful in predicting design decisions. In this study neuroscience and architecture are used to generate research on how space users perceive their physical environment and generate psychological responses to it. The aim is to predict consequences of design decisions and to support design proposals that enrich human experience.

COMBINING QUALITATIVE AND QUANTITATIVE APPROACHES

Relying on the validity of subjective human feelings as the basis of a scientific approach (Alexander, 1979) and using a holistic approach to find out how people '*feel*' about the spaces within which they live through narrative inquiry, may provide new information to help designers plan spaces that generate atmospheres that are conducive to human well-being. Table 6-1, Environmental Characteristics of Architectural Spaces, evolved first from the authors self-inquiry, then from the narratives of residential and office space users who narrated their stories as to what environmental characteristics of architectural spaces had influenced their well-being over a 25-year span.

This information can be complemented using neuroscience and architecture measure for data on brain behaviour that design professionals may use to design spaces that generate better human experiences. Eight neuroscientific correlates, derived from Zeisels' (2006) Brain Design Principles, illustrated in Table 6-2, were used to explore how environmental characteristics contribute towards employee feelings about their office environment. These *profound and universal, deep healing design principles* are applicable not only for people

with Alzheimer's but also for people in other settings, such as offices. These principles dictate basic elements of the space that help Alzheimer patients function and feel better in their living environments.

The following hypotheses were tested using a qualitative and a quantitative method of research to explore how environmental characteristics of architectural spaces intangibly influence human well-being:

1. Peoples' moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit.

2. Setting the right mood for space users while conveying a positive atmosphere (good environment/energy in) will generate feelings of well-being and therefore less stress and adaptation (bad environment/energy out) to spaces they occupy.

3. Quantitative data can be used to flesh out and expand the results of qualitative data analysis.

METHODOLOGY

The first stage of the study was the author's self-inquiry about feelings that she recalled concerning the atmospheres of architectural spaces and the moods she experienced in the spaces where she worked and lived. The author listed elements of the atmospheres she felt affected her mood, satisfaction and well-being over a 45-year period. These experiences ranged from when she was a child to adulthood, and in different homes where she lived, schools she attended and places where she worked.

This personal narrative was then broken into meaningful analytic groups by placing key words beside each statement produced by the narrator. The keywords were then used to create 43 categories that best represented environmental characteristics of architectural spaces affecting mood, satisfaction and well-being. The theoretical Model of Human Experiential Responses to Space, shown in Figure 6-1, was devised in part to explain the results. The model presents a dynamic process and is illustrated as a means to comprehend

that multiple aspects of architectural spaces have shaped and will continue to shape human behaviour, which in turn will affect long-term well-being.

Figure 6-2, Vischer's (2005) Environmental Comfort Model of User-Space Interaction: the comfort-productivity continuum, shows that a *good environment* provides *energy* for employees. The hypothesis *good mood = ability to focus attention* has been added at the top right corner to support the fact that *good mood* caused by *ability to focus attention* goes hand in hand with positive work performance. Where a *bad environment* signifies a *loss of energy* on the part of the employee, the hypothesis *bad mood = stress* has been added at the top left hand corner to support the fact that *bad mood* caused by *stress* goes hand in hand with negative work performance.

In order to test the hypothesis that people's moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit, findings from the initial self-inquiry of how intangible aspects of architectural spaces influence well-being were compared with narratives from three other participants. First, with findings from a 47-year-old female subject whose narration is based on residential interiors where she had lived in several cities around the world, then with those of two other participants between the ages of 40 and 50, based on their experiences of working in several different office spaces.

The selection criterion for the three participants was that they needed to have experienced different residential or office space settings during at least twenty-five years. This criterion matches the time span of the author's personal narrative. To ensure participation, it was important to involve participants that had the necessary time available to narrate their life story in terms of the residential or office environments that influenced their lives. It was also important to make sure that participants willing to participate in the study had the ability to express elements that are essential for the research.

Prior to participating in the research, participants were asked to read and sign a consent form advising that their participation was on a voluntary basis, that the information provided through their narrations was confidential, that they had the right to withdraw at

anytime by advising the researcher verbally and that any data collected at the moment of withdrawal would be destroyed.

Participants were also told that the objective of this research was to better understand how narratives can be used to generate knowledge on how architectural spaces influence human well-being and how elements of the environment affect peoples' moods and feelings. They were told that this research explores how environmental characteristics can contribute to human well-being and that the aim was to understand more about the predicted consequences of design decisions on human experience.

Participants were asked to recount their life story in terms of:

- How elements of their physical environment had influenced their feelings of well-being over the years;
- How their moods and emotions might have been affected by elements of spaces they occupied;
- How they felt the general atmosphere generated by environmental characteristics of architectural spaces had contributed to their overall satisfaction and contentment.

All the narrations were tape recorded and lasted between one to two hours. Interviews to conduct the narrations took place in the home of the residential narrator and at the office narrators' place of work.

The recorded narratives were transcribed into Word documents, saved as 'RTF' files and then transferred to an Atlas-ti program used for qualitative data analysis. During this phase, each file was analyzed separately and each narrated sentence was coded into one of the 43 categories that represented environmental characteristics generated from the initial self-inquiry. Inverse coding was performed, where each of the sentences was placed in its respective coded category. The resulting Codes-Quotation List was then printed and verified. A Codes-Primary-Documents-Table was then created using Atlas-ti and was printed in order to interpret results. Although every narrative is different, data analysis shows how environmental characteristics commonly affect moods, satisfaction and long-term well-being.

Data analysis was designed to enhance and enrich the framework for further studies in this area. The aim was to determine how all four participants felt environmental characteristics may have affected their moods and feelings over the years in different residential and office settings. The goal was to find elements at the intangible level of spatial experience that were common to users, no matter the age, gender, preference or cultural background of space users.

To complement the results uncovered through narrative inquiry, a more quantitative method using survey data was used to measure brain effects on interior design and to further generate knowledge on how architectural spaces influence human well-being. This research was conducted in three phases and involved fifty-eight staff members of the Society for Neuroscience (SfN) before and after their move to a new building. Founded in 1969, this world's largest organization of scientists and physicians has nearly 42,000 members in more than 90 countries and 130 chapters worldwide. Part of the mission of this non-profit organization is to advance the understanding of the brain and the nervous system by bringing scientists together to improve disease treatments and cures, to provide professional development activities, to promote public information and to inform legislators about recent scientific developments.

The first phase of the second study took place in the pre-move office where the SfN occupied the 3rd, 5th and 7th floors of a 15- storey building in central Washington, D.C. The main entrance to the SfN offices was located on the fifth floor and the building's elevator core connected the three SfN office floors. Fifty-eight employees responded to a digital Neuro-Environment Assessment Questionnaire – Pre-Move (see Appendix 2), which could be filled out digitally or manually. The question '*How do the following items contribute?*' related to a list of questionnaire items as most likely to play a role in respondents' answers.

The salient environmental characteristics in each of the eight categories were generated through expert observation prior to the study in order to predict eight brain-design correlates based on Zeisel's (2006) deep healing principles. These were considered predictive of three neuroscientific behaviours of mood, ability to focus attention, and stress. Data were collected by eliciting users' ratings of the salient environmental characteristics

pertaining to the eight principles using questionnaire surveys. Respondents were asked to rate each item in terms of how these affected their experience working in the office, with a choice of responses: *A lot - A little - Not at all – Has opposite effect*. These data were then analysed to determine how each of the eight brain-based behaviours were affected, and these in turn allowed us to assess the influence of the physical environment on established neuroscientific concepts of mood, ability to focus attention and stress.

The second phase of the study was conducted six months after the move to new premises, also in downtown Washington, D.C., where employees completed the same digital neuro-environment assessment questionnaire, (see Appendix 3). As results from the first survey had been made available and used by the designers of the new offices, questionnaire items in the second survey were changed slightly to reflect new features that were present in the new workspace. These changes were based on expert observation and discussion of design program objectives that were taken into consideration for designing the three floors at the new office.

Design objectives for the new office included goals relating to each of the eight neuroscientific correlates intended to make the new SfN offices more supportive of employees' ability to do their jobs, and in turn improve employees' mood, ability to focus attention and reduce work stress. The goal of this phase of the study was to compare the environment of the new offices with that of the old offices and to assess how – and how much – the new workspace affected brain activity. Employees again responded to the question *'How do the following items contribute*?' which related to a list of environmental characteristics judged to be correlated with brain behaviour.

Responses for both neuro-environment assessments (old and new offices) were grouped into their corresponding eight neuroscientific correlates in order to identify which features of the workspace design contributed to employee feelings and behaviour in regards to mood, stress and work satisfaction. Survey data were entered into Statistical Package for Social Sciences (SPSS) and Statistical Analysis System (SAS) for analysis using Correlation Analysis, Analysis of Variance, and cross-tabulated tests of significance.

Results from the two neuro-environment assessments were used to create a correlation matrix to measure how brain activity responded to the built environment in the old and new offices. Testing allowed us to verify which environmental characteristics within the eight brain-based neuroscientific behaviours correlate most, or least, significantly with features of the office environment. Finally, the links connecting the eight neuroscientific correlates with the three neuroscience concepts of mood, ability to focus attention and stress were evaluated as a holistic way of measuring how users' brains respond to the built environment for work.

Results were verified with the environmental characteristics derived from the narrative inquiry to see if there were any matching, differing or overlapping categories that could be said to influence human behaviour. The goal was to see how well results from the two methodological approaches could be integrated in order to test the hypotheses set forth at the beginning of the study.

The third phase of the study was conducted in the new office to collect data through on-site observation, photographs, behavioural mapping and group interviews. These data were collected nine months after the move into the new building.

RESULTS

Table 6-1 summarizes the Environmental Characteristics of Architectural Spaces that emerged from content analysis of all four narratives in the first study. Each subject is identified by an abbreviation where SI represents the findings from the researcher's self-inquiry and R represents the findings from the narration based on residential interiors. 1 and 2 represent the findings from participant (1) and participant (2) derived from the office narratives. As mentioned, the first 43 categories representing environmental characteristics were initiated from the authors' self-inquiry (SI). Budget and preference emerged from participant(R)'s data analysis. Preference emerged from participant(1)'s data analysis whereas efficiency, age and feelings of belonging emerged from participant(2)'s data analysis. These five categories are found at the end of the table and are numbered between 44 and 48.

In the table, numbers in parentheses indicate the quantity of times these characteristics were mentioned by all four narrators. Bold numbers in parentheses indicate the number of times characteristics were most often mentioned by the four narrators. These are control (103), light (102), satisfaction (103), setting (118), and space characteristics (292).

Characteristics that vary the most from one narrator to another as to the number of times that they have been mentioned by each participant are feelings, flexibility and space characteristics. Feelings is most often mentioned by participant (SI), flexibility is most often mentioned by participant (2) in the office narrative, and space characteristics is most often mentioned by participant (R).

Characteristics that are mentioned similar amounts of times by the four participants are colour, environmental factors and relocation. Pets and rooms with a story to tell are categories only expressed by participant (R) whereas efficiency is only expressed by participants (1) and (2).

Data from participant (SI) reveals that aspects of architectural spaces mentioned most often as contributing to her overall satisfaction and contentment are feelings and space characteristics. Environmental characteristics most often mentioned by the residential narrator (R) are materials and space characteristics. Data from participant (1) reveals that color, comfort, control, light, satisfaction, setting, and space characteristics are mentioned most often. On the other hand, data from participant (2) reveals that adapting, cognition, comfort-discomfort, control, ergonomics, flexibility, nature, noise, satisfaction, social aspects, space characteristics and stress are mentioned most often.

In the second study, results from analysis and cross-validation of both neuro-environment assessments, as well as content analysis of observation and group interviews reveal that design based on neuroscientific objectives improved employee feelings about the space in the new office in regards to three ‘office-wide’ environmental attributes. The Pre- and Post-Move Neuroscientific Correlates shown in Table 6-3 indicate that ‘sense of safety and security’, ‘wayfinding’ and ‘feeling part of a unified cohesive organization’ are the three neuroscientific correlates that were rated higher in the new office. Therefore, they

contribute most to employee feelings of the environment and that in turn these factors affect their moods, ability to focus attention, and levels of stress**.**

On the other hand, results show that employees were more satisfied in their old office when it came to five neuroscientific correlates. Outdoor awareness, ability to withdraw from co-workers and unwind, understanding what is expected in the work environment, support and comfort for personal and work needs as well as sense of pride and accomplishment were rated higher for the old office than they were for the new office.

The Pre- and Post-Move Work Contribution and Satisfaction Ratings shown in Table 6-4 indicate that both work contribution and satisfaction were rated higher in the new office. The Correlation Matrix shown in Table 6-5, indicates that support and comfort for personal work needs correlates highly with several other neuroscientific correlates in both the old and new office. Understanding expectations, ability to withdraw and unwind, awareness of outdoors and nature and sense of pride and accomplishment are the factors that most affect employees' sense of being supported at work. Correlation coefficients for these factors in both the old and new offices are significant at over 0.6.

Results show that fourteen out of sixteen items at the old office and sixteen out of eighteen items at the new office are significantly correlated with support and comfort for personal work needs. The most significant items at both locations are *windows and natural light in offices* and *ability to display personal objects in private office*.

The Correlation Matrix also indicates that feeling part of a cohesive organization correlates the least with other items in both the old and new offices. Ability to withdraw and unwind, wayfinding and support and comfort for personal work needs are the factors that contribute least to users' feeling part of a cohesive organization. The correlation coefficients for these factors are below 0.3 in the old office. On the other hand, ratings indicate that wayfinding and support for personal work needs are much improved in the new office.

One out of five items at the old office and six out of six items at the new office are significantly correlated with feeling part of a cohesive organization. The most significant

item at the old office is *main entry lobby on 5th floor*. The two most significant items at the new office are *central stair connect three office floors* and *main lobby on 10th floor*.

As indicated in the second to last column on the right hand side in Table 6-5, Correlation Matrix, the average ratings for each neuroscientific correlate were calculated for both offices and were inserted in Table 6-6, Space Users' Responses to the Environment. The ratings for Mood, Ability to Focus Attention and Stress, were placed on the left hand side for the old office and on the right hand side for the new office.

Table 6-6, Space Users' Responses to the Environment, indicates the means for those scales predictive of the eight neuroscientific correlates and how they are linked to the three neuroscience concepts of mood, ability to focus attention and stress in the old and new offices. Results show that ratings were generally higher for the new office than they were for the old office. For example, support and comfort for personal work needs was rated highest (4.1) for the new office and therefore shows better mood and less stress. Wayfinding was used as a measure of ability to focus attention, and was rated relatively the same for both old and new offices. Feeling part of a cohesive organization was used as measures of ability to focus attention and stress and was rated lowest for the old office.

DISCUSSION

Both the narrative inquiry and the survey research complement each other. First, the qualitative research on narrative inquiry provided a framework from which to prove that architectural spaces are composed of environmental characteristics which together create atmospheres that affect user moods that can be expressed as feelings. Then, the quantitative research using neuroscience and architecture explored eight neuroscientific correlates derived from Zeisel's (2006) brain design principles to identify elements of the physical environment that could be used to design and improve a new office space.

The Model of Human Experiential Responses to Space, shown in Figure 6-1, provided the framework for the study on narrative inquiry which was initiated in search of intangible aspects of architectural spaces that influence human well-being. Data derived from the four narratives revealed how multiple environmental characteristics of architectural spaces shape human behaviour and affect their long-term well-being.

For example, participant (SI) mentioned that crowding and noise were elements that bothered her most in architectural settings. She felt that privacy was important and she avoided noisy neighbourhoods. She also stated that space characteristics, materials, views to the outside, nature and preference were important to her.

Data from participants (1) and (2) in the office space narratives show that both participants felt space characteristics improved their degree of satisfaction in the last office they occupied. Their office no longer had bad odours, they had natural light and better views to either the outdoors or to a garden. Both of their dream offices would have views to the outdoors as essential elements for them to regenerate and both participants wished to have an easy transportation to work.

Results from the narrative inquiry provided a basis from which to prove the hypothesis that people's moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit and that such intangibles can be identified by analysing qualitative data.

As can be seen through this study, though the experience of home is essentially one of personal needs and intimacy (Cooper Marcus 1997) environmental characteristics can also be designed to suit the needs of space users in other settings such as offices so as to heighten sense of satisfaction and well-being. Since the quality of office space is more and more recognized as one of the determining factors guiding efficiency, productivity and even the morale of office workers (Fischer and Vischer 1998), this may also be true for residential settings, or any other type of space.

The first study provides directions for further research whereby a qualitative approach using narrative inquiry can be used as a tool to access human experiential responses to space. The second study goes a step further into how experiential responses can be used to design spaces that respond to space users' needs. It uses the nascent discipline of neuroscience and architecture to generate additional knowledge on how environmental characteristics of architectural spaces influence human well-being. Data derived from the research findings of the second study were used to design the new office space of the SfN in terms of space users' needs. Findings from each of the studies provide

designers with different kinds of information that can be used prior to the space planning process to help them design spaces that are geared towards human well-being. Both studies contribute to finding out what it is about the environment that makes spaces users feel the way they do. Both studies have demonstrated that architectural spaces are composed of several environmental characteristics, derived from the 48 categories, found in the author's personal narrative and in the residential and office space narratives. Together, these environmental characteristics generate atmospheres that are intangible and affect user moods and shape human experience.

Results of the survey research filled in some of the gaps left by the narrative inquiry. It used Zeisel's (2006) existing framework of deep healing design principles that are used to design spaces for Alzheimer patients, which provided a framework from which people with normal brain states could be queried. This study also allowed professionals from different fields, such as neuroscientists, environmental psychologists, architects, designers and researchers to find solutions geared to the long-term well-being of space users. The neuroscience and architecture evidence found in this study suggests ways in which environmental characteristics of architectural spaces impact the brain.

Results suggest that neuroscience / human-behaviour / built-environment interrelationships can be regarded as means to better meet human needs. Environmental characteristics shape the patterns of people's behaviour (Pilatowicz 1995), impact on the human brain (Zeisel 2006) and affect people's mood, ability to focus attention and stress level.

In comparing both studies, it can be seen that some of the 48 environmental characteristics of architectural spaces seen in the first study mentioned as affecting user moods and shaping human experience were similar to some of the eight neuroscientific correlates used for the framework in the second study. For example: sense of safety and security in the second study relates to *security* in the first study; support and comfort for personal work needs in the second study relates to *comfort* in the first study; and feeling part of a unified cohesive organization in the second study relates to *feelings of belonging* in the first study. In terms of more specific items, both studies also referred to similar

environmental characteristics such as air quality, color, finishes, furniture, lighting, materials, noise, plants (nature), views and windows.

Both methods can be overlapped by first identifying through narrative inquiry which environmental characteristics narrators feel affect their mood and well-being. This data can then be used to further investigate how these environmental characteristics can affect brain responses. For example, when office space narrators in the first study mention that colors and materials affect their sense of comfort, this can be further explained by users' ratings of support and comfort for personal and work needs in the second study. Being able to identify space-users' feelings about the space they occupy can help organize data in preparation for quantitative research such as neuroscientific measures in order to get a better understanding of the complex relationship between human behaviour and the built environment.

Results indicate that narrative inquiry participants attested to how they individually felt environmental characteristics affected their overall well-being, whereas the questionnaire survey helped to unveil what other space users felt about certain elements of the architectural space so that data could be used to justify the design of a new office space that corresponded to overall space user needs.

Using the neuroscientific approach, data collected from participants in the old office was used to design the new office with a set of design objectives which were aimed at improving employee feelings towards the design of the new office.

Figure 6-3, Design Elements Shown to be Affected by Neuroscientific Correlates, shows examples of design elements in the new location that most contribute to brain-specific design principles assessed in the present study. Sense of safety and security is affected by such design elements as *electronic key card to enter SfN offices* and *security guard at building entrance*. These design elements may help reduce stress and improve mood for employees since sense of safety and security refers to mood and stress (see Table 6-6, Space Users' Responses to the Environment). These results illuminate what the narrative participants thought were important. For example, when participant (2) mentions stress several times in her narrative, this may be due to the fact that she needs to have

control over her space, must adapt to constantly changing situations and needs to listen to what her employees say when they share information.

Wayfinding is affected by such design elements as the *central staircase unifying three floors, plaques with ID of office occupants /signs /directories, similar hallway and office layouts and windows to the outside*. These design elements may help users to better focus since wayfinding refers to ability to focus attention (see Table 6-6, Space Users' Responses to the Environment). These results are also comparable to what the narrative participants thought were important. For example, when participants (1) and (2) mention that their dream offices would have views to the outdoors as essential elements for them to feel regenerated, this also helps them to better focus.

And, feeling part of a unified cohesive organization is affected by design elements such as *main entry lobby on the 10th floor* and *standardized office furniture materials*. These design elements may help employees focus more and feel less stressed since feeling part of a cohesive organization refers to ability to focus attention and stress (see Table 6-6, Space Users' Responses to the Environment). These results are also comparable to what the narrative participants consider important. For example, when participant (1) mentions his discomfort in humid, polluted and noisy workspaces, he also mentions that his work requires him to be in a closed office where he can work without being disturbed for hours at a time. He also mentions color, comfort, control, light, satisfaction, setting, and space characteristics most often in his narrative. These design elements may help him focus and feel less stressed since they seem to be important elements for his comfort and well-being.

Results from this research provide a basis from which to prove the hypothesis that setting the right mood for space users while conveying a positive atmosphere (good environment/energy in) will generate feelings of well-being and therefore less stress and adaptation (bad environment/energy out) to spaces they occupy. This refers to Vischer's (2005) Environmental Comfort Model of User-Space Interaction: the comfort-productivity continuum, shown in Figure 6-2, which shows that a *good environment* provides *energy* for employees and goes hand in hand with positive work performance and that a *bad environment* goes hand in hand with negative work performance.

For example, data analysed from the neuroscientific assessment of the old office guided the design of the three floor spaces in the new office. During group interviews many participants mentioned that the space in the new office was cold, that they felt drafts of air and that they had to bring extra sweaters to keep warm. Some felt that the huddle rooms were great for meetings but these did not offer a space for someone to retreat and unwind. One person felt that she had 'lost her own space' when moving to this new office location. These comments show that employees are now adapting to a new location that does not necessarily respond to the habits they had in the old office. These results also compare to what the narrative participants thought were important. For example, when participant (SI) mentions '*I always felt good in that home*' or '*the rooms felt cold*' this may signify that in both studies participants wish to feel good in the spaces they occupy and don't appreciate feeling cold or having to adapt.

Study results confirm that environmental characteristics do shape the patterns of people's behaviour (Pilatowicz 1995) and impact the human brain. Using Environment / Behaviour / Neuroscience assessments can help determine how the environment performs with specific focus on neuroscientific responses such as mood, ability to focus attention and stress. This study demonstrates that it is becoming more possible to design spaces that actively influence brain states that contribute to productivity and quality of work life (Zeisel 2006).

CONCLUSIONS

This research demonstrates that combining qualitative and quantitative approaches is an effective way of measuring the intangible aspects of architectural spaces that enhance mood, satisfaction and human well-being. Results demonstrate that environmental characteristics of architectural spaces generate atmospheres that are intangible, and in turn create moods that shape human experiential responses. Intangible aspects of architectural spaces refer to an architecture that fuses the immaterial and the material so that they are in conjunction and not in opposition (Hill 2006). Design, since it cannot be known in advance, can only arise from the involvement of space users themselves (Alexander 1975).

This research also demonstrates that quantitative data can be used to flesh out and expand the results of qualitative data analysis. There is a relationship between the two types of data, qualitative / narrative inquiry and quantitative / neuroscientific inquiry, since in both cases participants were able to identify environmental characteristics they felt affected their moods and satisfaction. In the first study, narrative inquiry was used to gather data to find out how participants from both residential and office space settings 'felt' environmental characteristics had affected their moods and satisfaction over the years. Narrative data analysis led to outlining a theoretical framework in the form of the Model of Human Experiential Responses to Space that explains key relationships between users and environmental intangibles. For example, when participant (SI) mentions that she feels uncomfortable in crowded and noisy architectural spaces, this refers to multiple environmental characteristics combined that create the atmosphere which is referred to in the model. This intangible atmosphere shapes a person's moods which can be expressed as feelings of discomfort in this particular example. The results of this study opened up inquiry into the intangible ways in which an individual feels about, perceives, or reacts to a particular environment or situation (Zeisel 2006). In the second study, a neuroscientific approach was used to gather data to find out how environmental characteristics might affect office users' feelings toward their work environment.

The two types of data also complement each other in that both studies were useful in finding out what it is about the environment that influences human well-being. The research on narrative inquiry provided qualitative data that was used to build a framework of 48 environmental characteristics of architectural spaces that were said to affect mood and satisfaction with participants in both residential and office space settings. Subsequently, neuroscientific inquiry was used to gather data in order to find out how space users felt the environment affected their mood, ability to focus attention and stress levels before and after their move to a new office.

Using personal narrative as a way to access experiential material can allow foreseeing design solutions in the pre-design phase just as the neuroscientific method does. During narrative inquiry, narrators bring a new area of knowledge, one that comes right from within. This can also be seen by using environment / behaviour / neuroscience

research methods that measure internal states of our minds and bodies in response to specific environmental conditions. This leads to an understanding of the brains' neuronal structure and processes which can be incorporated to architectural designs that support human activity (Zeisel 2006, p 371). Together, both methods gear towards understanding what humans need in order to have a feeling of satisfaction in the environments within which they live and work.

There are differences in the results yielded by both research methods. Narrative inquiry focuses on a qualitative approach where subjective user feelings form the core of the study. Through narratives the subject is the main focus and stories contribute to divulging human subjective thoughts directly from the narrator's voice. This approach ensures that design solutions may be viewed from multiple lenses and from the experiences of actual space users. Neuroscientific research relates to a quantitative, scientific approach. It gears towards tools that help measure aspects of brain physiology and behaviour in order to assess clues to what characteristics of environments enhance human well-being.

Combining narrative and neuroscientific inquiry provides useful data that is geared towards designing spaces for human well-being. By exploring both qualitative and quantitative approaches it can be seen that each can be used as the backbone for the other while doing research. As well, they can both be used to corroborate the environmental characteristics, tangible or intangible / visible or invisible, that affect human well-being.

Research that involves narrative inquiry as well as neurosciences and architecture offers an interesting solution to finding out what environmental characteristics of architectural spaces contribute to the well-being of space users before the planning process begins. Subjective expression of the individual may serve as key to discovery (Budd 2000) and relying on the solidity of subjective human feelings as a scientific approach may have far more value than preconceived concepts and opinions (Alexander 1979).

Since our surroundings shape our moods and ideas (de Botton 2006), findings from both studies demonstrate that environment-behaviour research can be useful to learn how an individual feels about, perceives, or otherwise reacts to a particular environment or situation (Zeisel 2006). Individuals who are more satisfied with their physical work

environment are more likely to produce better work outcomes (Kamarulzaman, Saleh et al. 2011). Though further research is needed to find out what intangible aspects of architectural spaces influence human well-being, both studies aim at increasing the knowledge base in the Interior Design Body of Knowledge Via Career Cycle and Health/Safety/Welfare Framework (Guérin and Martin 2004) and reinforce the value of discourse in design studies. The goal is to increase awareness that interior spaces do impact human well-being and that architecture can be regarded as a solution to satisfy human physical, functional, social and psychological needs.

It is essential that spaces be in symbiosis with occupants (Serfaty-Garzon 1999) and collaboration between scientists and designers could lead to pre-design solutions that may help impact long-term well-being for space users. As new tools are developed, '*what we feel*' may provide the scientific basis for the importance of design on our mental and physical well-being (Eberhard 2003, Eberhard 2005).

This study shows that narrative inquiry and neuroscientific research complement each other as methodological approaches to finding out what it is about architectural spaces that influence human well-being. Combining both methods can be effective to help generate information that designers can apply to their projects. Data collected through narrative inquiries provided the basis from which to begin the research. It allowed the creation of categories that were grouped into environmental characteristics of architectural spaces that together constitute atmospheres within environments where people can be affected in ways that are neither direct nor always explicit. This framework then provided the precincts with which neuroscientific based data from the office space study was correlated. In both studies, participants were able to provide data as to how they felt intangible aspects, or environmental characteristics, derived from the physical environment affected their moods and emotions through different case studies.

As research between neuroscience and architecture aims at a greater understanding of architecture to enrich the human experience, those who design places for human use must work side by side with neuroscientists to find research-based knowledge that will allow them to predict consequences of design decisions and provide a scientific basis for

their design proposals. The goal is to collect data (using both methodological approaches) that can be useful for designers to create spaces that allow people to reach their full potential in whatever kind of space they live, work or play (Whitelaw in Eberhard, 2003).

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ENVIRONMENTAL CHARACTERISTICS OF ARCHITECTURAL SPACES

COMPARING SELF INQUIRY (SI), RESIDENTIAL NARRATIVE (R) AND OFFICE SPACE NARRATIVES; (1, 2)

#	Environmental Characteristics	Number of times comments have fit into this category			
	Participant	SI	R	1	2
01	Accessories (9)	1	8	0	0
02	Adapting (37)	16	7	0	14
03	Air quality (11)	8	0	2	1
04	Air temperature (13)	7	3	3	0
05	Appropriation (26)	8	6	0	12
06	Assurance (2)	1	1	0	0
07	Cognition (22)	1	1	1	19
08	Colour (75)	**21**	**11**	**21**	**22**
09	Comfort (68)	3	14	24	27
10	Community (39)	3	18	6	12
11	Control **(103)**	7	**26**	21	49
12	Crowding (54)	**22**	25	5	2
13	Environmental factors(26)	**7**	**10**	**5**	**4**
14	Ergonomics (43)	2	12	5	25
15	Feelings (95)	**77**	3	8	7
16	Flexibility (88)	4	1	2	81
17	Friendships (27)	20	3	1	3
18	Furniture arrangement (48)	15	28	2	3
19	Geographic situation (87)	3	22	11	3
20	Light **(102)**	29	32	23	18
21	-Artificial	5	0	6	0
	-Daylight	24	32	17	18
	Materials (96)	38	40	16	2
22	Memories (8)	3	4	0	1
23	Nature (92)	38	**29**	0	25
24	Noise (43)	**15**	**4**	4	20
25	Odours (12)	5	0	5	2

#	Environmental Characteristics	Number of times comments have fit into this category			
	Participant	SI	R	1	2
26	Ownership (21)	4	10	4	3
27	Pets (6)	6	0	0	0
28	Perception (47)	8	21	15	3
29	Privacy (55)	7	**23**	10	15
30	Relationships (7)	2	2	0	3
31	Relocation (23)	**2**	**6**	**4**	**11**
32	Rooms with story to tell (3)	3	0	0	0
33	Satisfaction **(103)**	**9**	30	33	31
34	Security (43)	25	14	3	1
35	Setting **(118)**	46	31	21	20
	-Architectural	**39**	31	18	14
	-Industrial	1	0	0	0
	-Urban	6	0	3	6
36	Social aspects (88)	11	23	19	35
37	Space characteristics **(292)**	**41**	**147**	51	53
38	Stress (26)	2	0	2	22
39	Style (45)	3	28	0	14
40	Territoriality (24)	13	1	0	10
41	Transportation (48)	3	18	11	16
42	Views (51)	21	**13**	7	10
43	Windows (41)	6	21	8	6
44	Budget (3)	0	3	0	0
45	Preference (23)	0	**22**	1	0
46	Efficiency (11)	0	0	7	4
47	Age (2)	0	0	0	2
48	Feelings of belonging (3)	0	0	0	3

Table 6-1 Environmental Characteristics of Architectural Spaces

BRAIN DESIGN PRINCIPLES			
1	Sense of safety & security	5	Awareness of outdoors and nature
2	Understanding what is expected at work	6	Support and comfort for personal work needs
3	Ability to withdraw & unwind	7	Sense of pride and accomplishment
4	Wayfinding	8	Feeling part of a cohesive organization

Table 6-2 Brain Design Principles (Zeisel 2006)

Neuroscientific Correlates		RATING	
		Old Office	New Office
		Means	Means
1	**Sense of safety and security**	3.54	**4.0**
2	**Wayfinding**	3.18	**3.9**
3	**Feeling part of a cohesive organization**	2.72	**3.8**
4	Outdoor awareness	**3.97**	3.8
5	Ability to unwind	**3.93**	3.5
6	Understanding expectations	**3.38**	3.3
7	Comfort and support	**3.92**	3.6
8	Sense of pride and accomplishment	**3.78**	3.5

Table 6-3 Pre- and Post-Move Neuroscientific Correlates

FACTORS		RATING	
		Old Office	New Office
Work contribution	Contribution to work	3.6	3.9
	SfN offices	3.5	3.8
	Personal workspace	3.7	3.9
Satisfaction	Satisfied with environment	3.6	4.0
	SfN offices	3.5	4.1
	Personal workspace	3.7	3.8

Table 6-4 Pre- and Post-Move Work Contribution and Satisfaction Ratings

Old Office - Correlation Matrix

Neuroscientific Correlates	1. Sense of safety & security	2. Understanding what is expected at work	3. Ability to withdraw & unwind	4. Wayfinding	5. Awareness of outdoors and nature	6. Support and comfort for personal work needs	7. Sense of pride and accomplishment	8. Feeling part of a cohesive organization	Totals above the 0.3 cut off	Addition of scores that are above the 0.3 cut off	In descending order of significance (1=most and 8= least significant)
1. Sense of safety & security	1.000	0.511	0.343	0.421	0.337	0.535	0.562	0.331	7/7	3.04	6
2. Understanding what is expected at work	0.511	1.000	0.453	0.506	0.464	0.602	0.549	0.436	7/7	3.52	3
3. Ability to withdraw & unwind	0.343	0.453	1.000	0.584	0.444	0.642	0.435	0.276	6/7	2.90	7
4. Wayfinding	0.421	0.506	0.584	1.000	0.333	0.612	0.594	0.279	6/7	3.05	4
5. Awareness of outdoors and nature	0.337	0.464	0.444	0.333	1.000	0.611	0.430	0.419	7/7	3.04	5
6. Support and comfort for personal work needs	0.535	0.602	0.642	0.612	0.611	1.000	0.622	0.270	6/7	3.62	2
7. Sense of pride and accomplishment	0.562	0.549	0.435	0.594	0.430	0.622	1.000	0.443	7/7	3.64	1
8. Feeling part of a cohesive organization	0.331	0.436	0.276	0.279	0.419	0.270	0.443	1.000	4/7	1.63	8

New Office - Correlation Matrix

Neuroscientific Correlates	1. Sense of safety & security	2. Understanding what is expected at work	3. Ability to withdraw & unwind	4. Wayfinding	5. Awareness of outdoors and nature	6. Support and comfort for personal work needs	7. Sense of pride and accomplishment	8. Feeling part of a cohesive organization	Totals above the 0.3 cut off	Addition of scores that are above the 0.3 cut off	In descending order of significance (1=most and 8= least significant)
1. Sense of safety & security	1.000	0.503	0.370	0.460	0.493	0.595	0.544	0.430	7/7	3.395	5
2. Understanding what is expected at work	0.503	1.000	0.535	0.430	0.499	0.632	0.583	0.351	7/7	3.530	4
3. Ability to withdraw & unwind	0.370	0.535	1.000	0.391	0.543	0.662	0.522	0.300	7/7	3.230	6
4. Wayfinding	0.460	0.430	0.391	1.000	0.314	0.485	0.506	0.419	7/7	3.005	7
5. Awareness of outdoors and nature	0.493	0.499	0.543	0.314	1.000	0.675	0.589	0.444	7/7	3.557	3
6. Support and comfort for personal work needs	0.595	0.632	0.662	0.485	0.675	1.000	0.673	0.378	7/7	4.100	1
7. Sense of pride and accomplishment	0.544	0.583	0.522	0.506	0.589	0.673	1.000	0.481	7/7	3.898	2
8. Feeling part of a cohesive organization	0.430	0.351	0.300	0.419	0.444	0.378	0.481	1.000	7/7	2.803	8

Table 6-5 Correlation Matrix

SPACE USERS' RESPONSES TO THE ENVIRONMENT							
Neuroscientific Correlates		Neuroscience Concepts					
		Mood		Ability to Focus Attention		Stress	
		Old Office	New Office	Old Office	New Office	Old Office	New Office
1	Sense of safety & security	3.04	3.40			3.04	3.40
2	Understanding what is expected at work			3.52	3.53		
3	Ability to withdraw & unwind					2.90	3.23
4	Wayfinding			3.05	3.00		
5	Awareness of outdoors and nature	3.04	3.56			3.04	3.56
6	Support and comfort for personal work needs	3.62	4.10			3.62	4.10
7	Sense of pride and accomplishment	3.64	3.90				
8	Feeling part of a cohesive organization			1.63	2.80	1.63	2.80

Table 6-6 Space Users' Responses to the Environment

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FIGURES

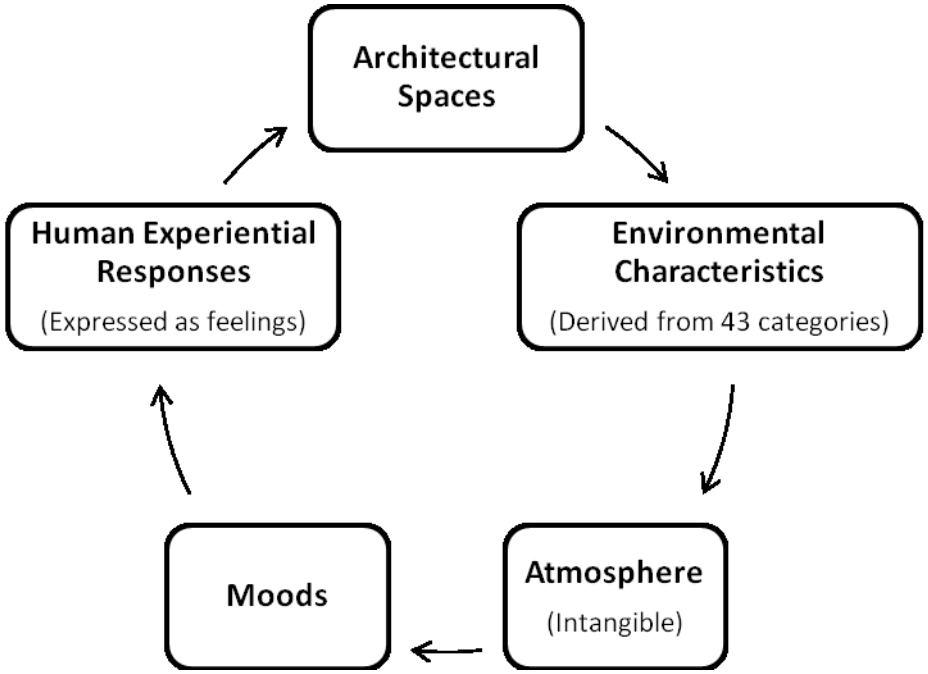

Figure 6-1 Model of Human Experiential Responses to Space

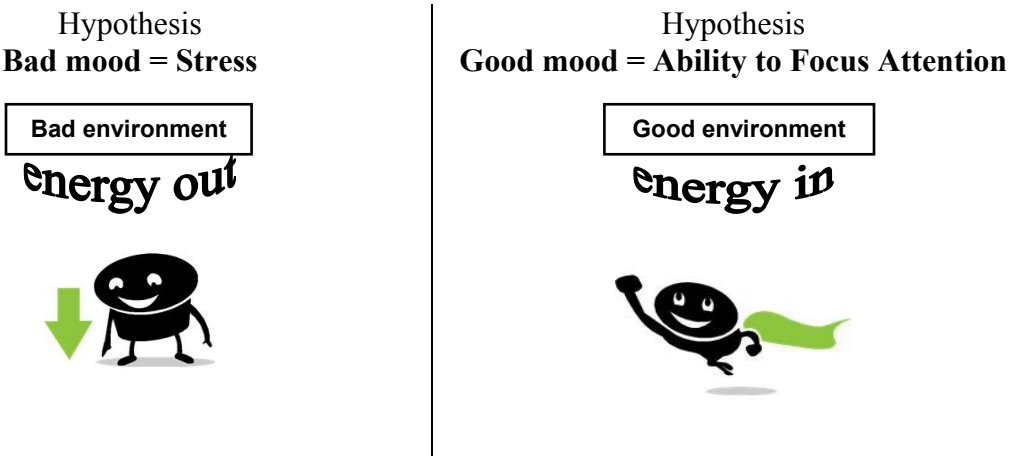

Figure 6-2 Environmental Comfort Model of User-Space Interaction: the comfort-productivity continuum (Vischer 2005)

	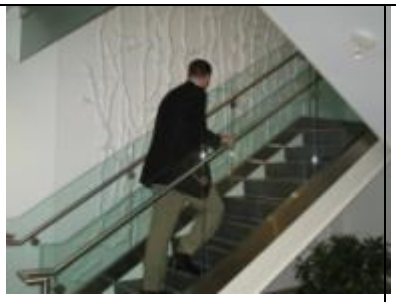	
Sense of safety and security Electronic key card to enter SfN offices	**Wayfinding** Central staircase unifying three floors	**Feeling part of a unified cohesive organization** Main entry lobby on the 10th floor

Figure 6-3 Design Elements Shown to be Affected by Neuroscientific Correlates

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CHAPTER 7

DISCUSSION

This research contributes to filling the gap within the Interior Design Body of Knowledge (Guérin and Martin 2004). Human needs are addressed through the lenses of human behaviour / built environment frameworks. First, narrative inquiry was used as a qualitative approach to identify what intangible aspects of architectural spaces influence human well-being. Then, a quantitative approach based on research in neuroscience and architecture was used to find out how office employees feel environmental characteristics affect their moods, stress levels and ability to focus attention. Neuroscience and Environment / Behaviour concepts using eight brain-based neuroscientific correlates (Zeisel 2006) were investigated in order to measure effects of architectural spaces on brain (cognitive) processes.

In conclusion, this chapter highlights the values in combining both research methods and how they contribute to the Interior Design Body of Knowledge (Guérin and Martin 2004). Similarities, differences, strengths and weaknesses of both methods are addressed as well as the importance of this research and its applications to design. The originality and contribution of this study are explained and the importance of building ties between design and research professionals in order to further research that contributes to this knowledge base in interior design.

CONTRIBUTION TO THE INTERIOR DESIGN BODY OF KNOWLEDGE

The interior design process follows a systematic and coordinated methodology, including research, analysis and integration of knowledge into the creative process, whereby the needs and resources of the client are satisfied to produce an interior space that fulfills project goals (FIDER 2006). Table 1-1 shows a partial view of the Interior Design Body of Knowledge via Career Cycle and H/S/W Framework (Guérin and Martin 2004). The highlighted *Human Behaviour / Built Environment* and *Human Factors* boxes in the *Experience* column represent the knowledge gap in the Interior Design Body of Knowledge (Guérin and Martin) and the areas of study that are addressed in this research.

Designing involves anticipating space-users' present and future needs, activities, conditions, equipment and special needs where data must be organized during the programming stage to be applicable to design (Kilmer and Kilmer 1992). Though this design process is very thorough, it is not necessarily always performed through a scientific research framework.

As can be seen in Figure 7-1, Design Process: Analysis and Synthesis (Kilmer and Kilmer, 1992), the design process generally involves two phases. During the analysis phase, the problem is identified, investigated and analyzed and ideas are generated about how to solve the problem. Then, during the synthesis phase, all the parts are put together in order to implement a solution (Kilmer and Kilmer 1992).

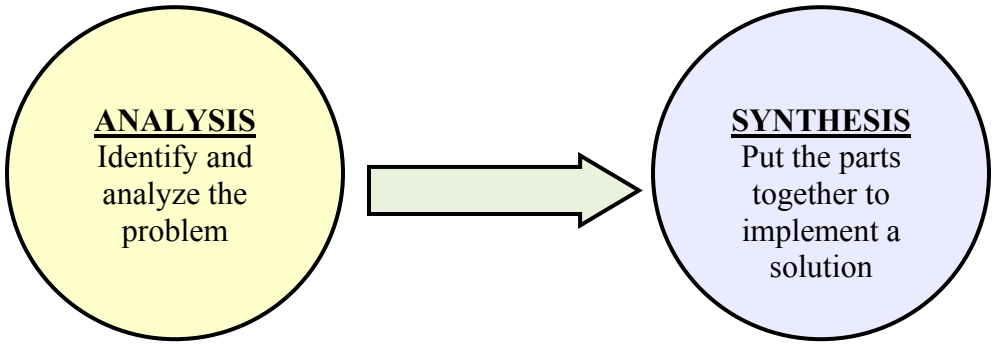

Figure 7-1: Design Process: Analysis and Synthesis
(Kilmer and Kilmer 1992)

Though analysis and synthesis are an integral part of the design process, design professionals also benefit from working with research teams and draw on theories, data and insight from research frameworks to take informed, practical action towards design solutions. Figure 7-2, Scientific Research as Part of the Design Process, shows that design analysis and design synthesis can be combined with scientific research as an integral part of the design process. Research generates new ideas and data which can be used to find solutions to real-life issues. The research and design collaboration performed at the Society

of Neurosciences, as described in Chapter 5, is a good example of how research can be combined with practice-based disciplines such as architecture and interior design to help improve efficiency and effectiveness.

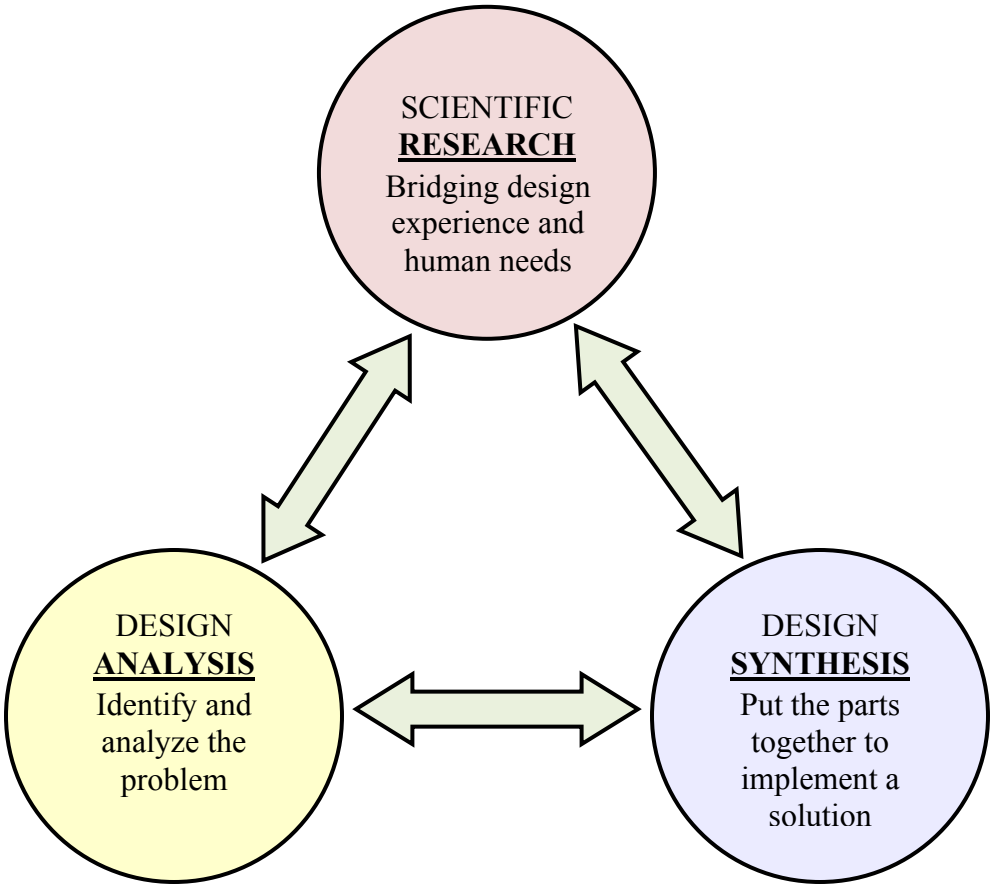

Figure 7-2: Scientific Research as Part of the Design Process

Informing the design process through research on human behaviour / built environment interrelationships can also enrich course curriculum, help shape students' experience and enhance what is taught at the college and university level. Providing students with access to new ideas and discoveries through scientific research can shape the way they design spaces for the health, safety and welfare of the public.

The research reported in this thesis has demonstrated that intangible aspects of architectural spaces matter and that they can be addressed throughout the design process

since they have a direct impact on space-user well-being. Though at this point only 48 environmental characteristics of architectural spaces can be shown to affect human well-being, further research will identify additional characteristics that will contribute to our knowledge about intangibles.

While the research results justify the usefulness of the theoretical Model of Experiential Responses to Space, additional ways of testing neuroscientific correlates such as Zeisels (2006) brain design principles will yield more empirical support. The research has demonstrated that specific environmental characteristics affect human well-being and contribute to users' *sense of place*, that is to how one feels or senses a specific *space*, or *place* according to the visible, invisible, tangible and intangible elements that comprise that space.

This research shows that it is through continual building of research knowledge and the building of ties between design professionals and research groups that practitioners may better understand the advantage of using scientifically based research findings. The study has demonstrated that design experience can be combined with research in order to better respond to user needs. Research using both qualitative and quantitative approaches enables us to dig deeper into human factors by first capturing subjective material through narrative inquiry and then using neuroscientific correlates to find out more systematically what it is about the environment that makes space users feel the way they do.

In order to contribute to the Experience part in the Interior Design Body of Knowledge, Alexander's (1979) theoretical frameworks were used to demonstrate how people's inmost '*feelings*' towards '*intangible*' environmental characteristics are a basis for design solutions. Recurring problems in our environment need solutions that can be used for many people, no matter what age, culture or gender. Buildings must have specific qualities that satisfy human needs and using narrative inquiry helped find environmental characteristics of architectural spaces that influence human well-being.

The aim of this research was to bring design practice into closer collaboration with researchers in order to access subjective user feelings that would bring to light design solutions that are geared towards human well-being. Systematically combining interior design and scientific research is relatively new and the integrated approach reported here represents a contribution to the Interior Design Body of Knowledge; first through narrative inquiry and then through neuroscientific research.

NARRATIVE INQUIRY

Alexander's (1979) notion of human feelings about architectural spaces set a theoretical framework for the first study. Using narrative inquiry, the initial personal narrative resulted in finding 43 categories representing environmental characteristics of architectural spaces that influence peoples' moods and satisfaction. These provided a framework within which to analyse additional narratives, but it also served to create the Model of Human Experiential Responses to Space, as shown in Figure 3-1. This model illustrates that architectural spaces are composed of environmental characteristics that generate atmospheres which are intangible, affecting user moods and shaping human experiential responses to space. These responses can be expressed as feelings of satisfaction and well-being or as feelings of discomfort which can lead to illness. This model was tested by having three additional participants narrate their stories as to how architectural spaces affected their moods and well-being over an approximate 25-year span. These additional narratives provided supplementary qualitative data that were used to find five more environmental characteristics of architectural spaces (for a total of 48) that were said to affect mood and satisfaction for participants in both residential and office space settings. These data were uncovered by having participants narrate their life stories as to what elements of the space affected their well-being.

The Model of Experiential Responses to Space and the results from the four narratives provided a basis from which to prove the hypothesis that people's moods and emotions are affected by elements of the space they occupy in ways that are neither direct

nor always explicit and that such intangibles can be identified by analysing qualitative data derived from narrative inquiry.

Listening, hearing and interpreting space users' narrations about their feelings towards architectural spaces (Alexander 1979) formed the core of this research. It was through the lenses of narrative inquiry that it became possible to capture how participants felt architectural spaces affected their mood and productivity over a long time span. This was the first contribution to the Interior Design Body of Knowledge. It was the gathering of data concerning intangible aspects of architectural spaces that influence human well-being, to see if there were underlying environmental characteristics that were similar (or different) from one narrator to another. This study helped unveil 48 environmental characteristics said to influence human well-being that could be used as a basis for further research. This evidence of human responses to spaces can be useful for space planners during the design process in order to define beforehand what best suits space user needs (Alexander 1979). This exemplifies that research and practice must go hand in hand in order to better respond to the needs of space users.

NEUROSCIENTIFIC RESEARCH

Explorations of intangible aspects of architectural spaces, mood, comfort and satisfaction through the study of office space users have provided the precincts from which to develop tools that access human experiential material that are necessary to back design proposals that promote well-being. The research performed has also been useful in testing the Model of Human Experiential Responses to Space to find out how intangible aspects of architectural spaces can enhance a person's mood, satisfaction and long term well-being. The model was used as a canvas to understand how architectural spaces generate atmospheres that shape human experiential responses that were then expressed as employee feelings towards their office environment. In order to further test this model, this research explored eight brain-design principles (Zeisel 2006), to find out how office employees felt environmental characteristics influenced their work contribution and satisfaction.

Zeisel's (2006) neuroscientific brain-design principles directly relate to basic elements of the space that help Alzheimer patients better orient themselves within their living environments. If brain design principles help improve the lives of people living with Alzheimer's disease, they may also be supportive to others who have normal brain states (Zeisel 2006). A survey approach was used to gather data in order to find out how space users felt their old and new office environments affected their mood, ability to focus attention, and stress levels before and after their move to a new office. This was the second contribution to the Interior Design Body of Knowledge. Data on neuroscientific concepts collected from participants in their old office was used to create a set of design objectives aimed at improving employee feelings towards the design of the new office. This was a direct link between research and practice where exchanges between researchers and design professionals provided concomitant data and solutions that geared toward providing space users with a new office space that responded to their needs.

What was learned from this study is that architectural spaces do affect cognitive processes, and that current knowledge from neuroscientific research can eventually contribute to better workspace design. Pre- and post-move neuro-environment assessment questionnaires provided data that could be used to design spaces to better respond to user needs and help improve long term well-being. Results show that environmental characteristics do affect mood, ability to focus attention and stress in office-workers.

Furthermore, in support of the Model of Experiential Responses to Space, Eberhard (2007) refers to the new, emerging field of neuroscience and architecture. To measure the brain/mind response to experiences in architectural settings, Eberhard's (2007) approach is to provide '*what we feel*' as the scientific basis for the importance of design on our mental and physical well-being. Eberhard (2003) stipulates that:

> ''as new tools are developed for understanding we will not only know that people have such experiences but we will also be able to answer how they have these experiences'' (p. 5).

In this study research results were useful to designers as they demonstrated if initial design objectives had been met. Survey results also enabled space planners to make design adjustments geared towards making employees more satisfied with the spaces within which they work. This is an excellent example of design experience and research working together for space-user fulfillment.

COMBINING NARRATIVE INQUIRY & NEUROSCIENTIFIC RESEARCH

Through both qualitative and quantitative approaches, this research explored intangible aspects of architectural spaces that enhance human well-being. First, narrative inquiry was explored to permit people's realities to be constructed through the narrating of their stories.

The purpose of using narrative inquiry is that it can expand the type of knowledge used to inform design and architecture both in practice and in education. Cost reduction and human contribution have become essential components of corporate success whereby alternative methods of teaching can include narrative research that will help to unveil key issues that are not always perceptible (Budd 2000). It is time more than ever for professionals to get close to space users and ask them how they feel about the spaces within which they live and why they feel the way they do. These findings may then be correlated with the studies in neuroscience that also search to know much more about how humans experience their environment, about why they have such experiences and about what might be done by designers to influence experience.

Advances in neuroscience and architecture are still in the early stages of development. Related to the field of environmental psychology neuroscience can be used to find out more systematically how environmental characteristics contribute to space users' comfort, satisfaction and well-being. It is clear that architectural spaces do affect cognitive processes and that current knowledge from neuroscientific research can eventually contribute to better workspace design. Pre- and post-move surveys have allowed the evaluation of data, known as post-occupancy evaluations (POE), that can be used to design spaces that better respond to user needs and that help improve long term well-being. POEs

provide better and more complete results when both quantitative and qualitative data are collected and analysed.

Subjective expression of the individual may serve as key to discovery (Budd 2000) and relying on the solidity of subjective human feelings as a scientific approach may have far more value than preconceived concepts and opinions (Alexander 1979). Environmental psychology requires the pursuit of both scientific principles and practical applications as it seeks to improve problems due to person-environment interactions. More precisely, environmental psychology studies transactions between individuals and their physical setting (Gifford 2002) where theory, research and practice aim at improving the relationship between man and his environment. Environmental psychologists and interior designers aim at improving environments that fulfill space-user well-being (FIDER 2006).

Though people's feelings may still be regarded as soft data that are not scientific (Alexander, Ishikawa et al. 1977, Alexander 1979), we have come an age where subjective feelings are increasingly considered as *solid* data from which designers can satisfy users' needs. Subjective qualitative research has become important in this new millennium since people no longer just rely on basic needs for survival, but also need self-fulfillment.

While personal narratives aim at capturing intimate thoughts that are of great value for understanding what users need to make their spaces more enhancing to live in, neuroscientific research in architecture aims at a greater understanding of architecture to enrich the human experience (Eberhard and Zeisel, 2004). Environment-behaviour research using neuroscience concepts reflects what is known about the neuronal structure and activity of the brain.

Research concerning how humans feel when they are in a space must be pursued. Whether young or old, male or female and regardless of their culture, humans have personal needs that must be addressed. Alexander (Alexander, Ishikawa et al. 1977, Alexander 1979) has been able to capture holistic reality that relates man to his/her interior environment. He combines what has been done in the past (studies of individual elements)

with what lays ahead (a combination of disciplines with the aim of helping humans live better lives).

As Gall (in Eberhard 2003) states:

> Part of our brain's development is that we learn about our world by trying all sorts of movements and our brain is constantly modified by these experiences, which in turn become our memories (p. 4).

The way individuals experience architecture affects how their brain responds to that space. As environmental variables such as temperature, light, noise, odours and furniture are constantly registered, cognitive senses are affected and perceptions and preferences for space are developed (Eberhard 2005). The body of knowledge based on further research in this field may be used as a theoretical basis to frame human experiential material.

Both qualitative and quantitative methods of collecting data to get at intangibles — those unnamed and ill-defined qualities of a space that affect users' mood without them being aware of it - are what ultimately are of value to designers. That is, having a sense of how users are affected intangibly or immaterially by interior space. Neuroscience can certainly bring a lot to the field of architecture and interior design and can continue to add to the Experience part that is lacking in the Interior Design Body of Knowledge.

Designing today must address the needs of space users directly and draw more concrete conclusions about how architectural spaces address human needs. Though narrative inquiry may serve as a useful methodological approach to access subjective information on how environmental characteristics of architectural spaces respond to user needs, neuroscientific research is a basis for predicting the consequences of design decisions. Together, both methods complement each other and offer quantitative and qualitative insights to design research. Following is an explanation of the similarities and differences, as well as the strengths and weaknesses, of each of the two methods used in this research.

Similarities

Using personal narrative as a way to access experiential material can help predict design solutions in the pre-design phase just as the neuroscientific method does. This can be seen by the telling of stories, where narrators bring a new area of knowledge, one that comes from within. Narrative inquiry brings the researcher closer to the space-user's inner feelings, by accessing data on differing views on how architectural spaces contribute to individual moods and feelings. This is also an effect of using Environment / Behaviour / Neuroscience research methods that measure internal states of minds and bodies in response to specific environmental conditions. This increases our understanding of the brains' neuronal structure and processes in response to architectural designs that support human activity (Zeisel 2006). Together, both methods gear towards understanding what humans need in order to have a feeling of satisfaction in the environments within which they live and work.

Differences

Differences between these research methods are that one method uses a qualitative approach and the other uses a quantitative approach. Narrative inquiry focuses on a qualitative approach where subjective user feelings form the core of the data collected. Through narratives the subject is the main focus and stories contribute to divulging human subjective thoughts directly from the narrator's voice. This approach ensures that design solutions may be viewed from multiple lenses and from the experiences of actual space users.

Neuroscientific research requires a quantitative approach using survey data. Its tools measure aspects of brain physiology and behaviour in order to assess what characteristics of environments enhance human well-being. Deep healing design principles (Zeisel 2006, p. 371) support people with Alzheimer's disease who need specially planned environments due to their difficulty in remembering physical environments and finding their way around. Therefore, planning spaces for office users that are conducive to their well-being in terms of cognitive mapping, memory and self-awareness facilitates designs that incorporate

understanding of the brain's neuronal structure and processes and lead to more supportive environments for everyone (Zeisel 2006).

In this study, the initial self-inquiry provided the basis from which 43 categories were derived in order to find out what intangible aspects of architectural space affect human well-being. Narrations from residential and office space users that followed served to solidify this base where five other categories were added. Although in each narrated story the number of times categories mentioned differed from one subject to another the initial 43 categories remained constant, indicating that environments which are conducive to human well-being have similar characteristics. While researchers can provide research frameworks that seek to find out about user needs that enhance their mood, satisfaction and well-being, space planners can use this information to design spaces that meet those needs.

Collecting data based on neuroscientific knowledge that identifies specific brain behaviour associated with the physical environment, not only helps people living with Alzheimer's become less agitated, less fearful and act more independently (Zeisel et al. 2003, Zeisel and Raia 2000, Zeisel and Tyson 1999), it also provides tools for professionals who aim at designing spaces for the well-being of all users. As professionals from disciplines such as architecture, design, environmental psychology and neurosciences combine their efforts to make architectural spaces better places to live in, space users will benefit from these collaborations.

Combined narrative and neuroscientific inquiry offer useful tools in providing data that is geared towards designing spaces for human well-being. The following paragraphs underline examples of the strengths and weaknesses of using both methods.

Strengths

Two complementary research methods were used in this research. Narratives highlighted requests that fostered solutions relating to subjective needs. Through this method participants recounted their stories about how they felt architectural spaces had influenced them. While they spoke, it was the expression of their faces that pointed to what

they really meant, what they really wanted, and what they really hoped was an ideal place to live or work in. Their voices allowed me to concentrate on their qualitative insight and feelings about the spaces they had lived in, rather than on the quantitative or aesthetic qualities of the spaces that were being described. Architects and designers often intuitively design buildings and spaces, whereas social and behavioural scientists add an understanding of how design impacts experience. To enrich this, neuroscience research goes a step further in understanding why this occurs (Zeisel 2006).

Both study results enrich the Interior Design Body of Knowledge because they relate to neuroscientific correlates that help predict consequences of design. For example, Table 3-2, Environmental Characteristics of Architectural Spaces, indicates that all participants mention *space characteristic*s as most influencing their moods in the places they lived for several years. This refers to the Human Behaviour / Built-Environment Interrelationship found in Table 1-1 and means that space does matter because human behaviour is shaped by the built environment and refers to the Experience part of the table. The first study is based on space users' experiences, and not on the designer's personal point of view. The second study shows that researchers were part of the team of designers, architects, engineers and project managers in order to provide them with scientific data, based on space-user needs that helped them design architectural spaces geared toward space-user needs. This also represents a direct link between the Experience and Human Behaviour / Built-Environment Interrelationship shown in Table 1-1.

Environmental characteristics provide comfort and satisfaction to space occupants and also provide the basis for user long-term well-being. Whether singled out or combined, these elements have an influential effect on human well-being. Theoretical frameworks for *comfort and satisfaction* (Vischer 2005) and *sense of place* (Abbate 2005) serve as a backbone for the present research. These support narrative inquiry and neuroscientific research in architecture that aims at finding out how environmental characteristics affect human well-being. The strength in combining both research methods is that narrated stories recall feelings of how participants feel environmental characteristics affect their well-being,

whereas neuroscientific research provides insight as to the internal states of our minds and bodies, such as mood, stress and ability to focus attention.

Weaknesses

Efforts to unveil intangible aspects of architectural spaces using a holistic approach, finding frameworks within the nascent discipline of neurosciences and architecture, and exploring two completely different research approaches necessitates extra time in combining two data collection and analysis efforts.

One of the weaknesses of narrative inquiry is that the researcher needs to invite stories that stimulate narrator reflections towards the subject of study. Said (1978) and Spivak (1998) have become interested in problems of narrative, voice and representation, especially the problem of how we misrepresent voices other than our own. As narrators hope to answer correctly the questions being asked, their voices must address their experiences so that the researcher can capture the hidden details of the object under study (Denzin and Lincoln 2005). In terms of validity issues, data may be seen as being analyzed and interpreted to suit the researcher's point of view. In these two studies, considerable efforts were made to represent as best as possible what narrators had recounted. When data was collected and transcribed, it was sent back to participants to make sure that what was written represented what they had said. When discrepancies were found, the researcher adjusted the data so that it would reflect what the participants had narrated.

Neuroscientific research does not yet provide all the answers to how environments can be designed to be conducive to long-term well-being. Brain-imaging techniques and neuroscientific tools can help measure aspects of brain physiology and behaviour that offer clues to what aspects of architectural interiors provide comfort and satisfaction to space users. For example, through research on the effect of lighting on children in classrooms, social and behavioural scientists have reported that learning improves when artificial light is reduced and daylight is increased (Zeisel 2006). Furthermore, different brain regions develop during different times throughout a person's lifespan.

Though much remains to be discovered, this research has permitted to establish a thought process for combining two different research methods in order to explore a world of intangibles in interior environments. Considering what cannot be seen or touched as scientific material to work with, was quite a challenge. The limitations of this study remain in the fact that it is a relatively new area of study and that using new research tools requires perseverance, time and patience in order to acquire the understanding that is necessary to pursue the research. Though an interesting framework has been set in place to find out what it is about architectural spaces that make space users feel the way they do, further studies will be needed to solidify the research findings outlined in this study.

WHY THIS RESEARCH IS IMPORTANT

In light of what was found in both studies, the gap found in the Experience part of the Interior Design Body of Knowledge can be eliminated by having researchers work in close collaboration with design professionals to make sure that time is well spent collecting and analyzing data that is based on space-user needs in the early stages of the design process. Clients are often focussed on space savings and cost efficiency rather than subjective user needs. Emphasis must be put on working with researchers and space users and to make clients understand that space user satisfaction is rewarding in terms of work productivity and efficiency.

Though most design practitioners would agree that they collect data at the beginning of any design process and use this information in order to design architectural spaces based on client needs, this process can be improved. Working with researchers who can provide designers with qualitative and / or quantitative scientific research data that has been analyzed before initial design processes take place can add tremendous value to the design process and can extend beyond the limitations of data typically collected during the design process.

Research and design can collaborate to make architectural spaces more enriching and more fulfilling. Research and design combined may eventually become part of

academic curriculum if scientific research becomes an essential part of the design process. If scientific based knowledge and practice based experience are taught in the early stages of the curriculum it will become natural for students and professionals to go a step further into finding out what it is about architectural spaces that influence human well-being. It is hoped that space users will become increasingly involved in the design process in order to inform researchers and designers who will take this information and work together to ensure that scientific data can be used to design spaces for the benefit of those who will live, work or play in them.

Adding scientific research to interior design is important. Research based material provides a rich foundation from which designers can begin their planning process. Narrative inquiry, neuroscientific research and interior design together give space planners a crucial role to play in society: to design spaces based on new knowledge of brain and cognitive processes in regards to interior space. Awareness of how people are affected by intangibles will bring real innovation.

In medical fields it is important to test pharmaceutical products for their side effects before they are given to humans. Therefore, in design based fields it is just as important that studies be done to verify how people feel environmental characteristics affect them before designers can propose solutions to fit human requirements. Environments play a major role in shaping the human brain and impacting human development and tools must be used to facilitate this process.

Architecture contributes to human experience and the more space users feel in harmony with the environment that surrounds them, the more they will experience good mood, and experience feelings of comfort and satisfaction. When out of tune with the environment, humans must continuously adapt. This can lead to stress and can cause eventual health problems (Fischer 1983, Wener et al., 2003, Vischer 2005, Zeisel 2006).

Research has revealed elements of architectural spaces and their influence on human well-being. For example, Alexander, Ishikawa et al. (1977) have demonstrated the

following since the 70's: natural light is important and the placement of windows on two walls for every room is an important consideration; the shape of a building shapes its interior and this in turn has a critical effect on people's comfort and well being; feelings of privacy or overcrowding vary from person to person; professionals must learn to work with creating the greatest feeling of spaciousness, as it seems that by providing more space would make it easier to solve problems of privacy and overcrowding; smells and sounds can enliven a room therefore the smell of flowers and gardens can be brought inside our living spaces; views to the outside are important so that we may see trees, water and fire to get a feeling of connectedness (Alexander, Ishikawa et al. 1977).

Space planning experts do a lot to make spaces as functional and aesthetically pleasing as possible. Combining research with design is a way of engaging space users in the design process. Giving them a chance to express their needs, listening to their innermost feelings and involving them in the design process has tremendous value. It adds further insight to design solutions and space users feel privileged because their views are being valued and their ideas are being taken into consideration. Furthermore, when space users are listened to, they feel respected and this usually results in better employee performances and better productivity (Vischer 2005, Zeisel 2006).

Applications to Design

An increasing number of practice-based disciplines are embracing narrative inquiry to teach the more intangible, human-centred issues of professional practice (Danko, Meneely et al. 2006). Each story is authentic and rooted in the here-and-now of the most urgent issues facing business and design practice today (Danko, Portillo et al. 1999).

By using neuroscientific correlates derived from profound and universal brain design principles (Zeisel 2006) to find out how people feel environmental characteristics affect them, design solutions can be based on shared user visions. This can be done by involving space users in the research process to find out how they feel environmental characteristics influence their mood, satisfaction and well-being. In the case of narratives, captured intimate thoughts, which questionnaires or interviews do not necessarily reveal,

can be used by space planners to design spaces that will permit individual users to reach their full potential.

People's realities are constructed through narrating their stories (Marshall and Rossman 1999) and they feel the need to share their stories in order to situate themselves amongst the world around them. It is by organizing people's spoken, unprocessed material that researchers can have access to authentic information from which designers can begin to design with. These data capture the cultural richness that augments scientific inquiry (Portillo 2000) and provide stories based on the subjective reality of end-users, clients and designers. Furthermore, interpreting interior space as a narrative adds depth and breadth to the understanding of how the environment is psychologically inhabited by the individual (Ganoe 2000).

Empirical research using measuring instruments like a survey questionnaire can also bring a lot to design. In this study it was useful in reaching out to several participants at a time in order to collect a wide range of information on how environmental characteristics affected the brain states of space users. This type of research also enabled to use statistical software in order to determine validity, reliability and significance while analyzing multiple variables at a time. The goal was to find out what similar, or different, elements of architectural space affect mood, ability to focus attention and stress so results of the research could be used to design the new office. For example, when participants mentioned that they did not feel that they were part of a unified, cohesive organization in the old office, this was probably due to the fact that the three office floors in the old office were accessed by a main-building elevator core. Thus, data results were used to design an internal staircase that joined the three floors of the new office. Survey questionnaires served as a means to suit the research intention to the research problem. The intention was to provide scientific data results to the design professionals which would nourish an understanding of what was needed as spatial characteristics in the new office.

As a way of cultivating a more reflective practitioner and nurturing an intellectual and emotional development, personal narratives provide emotional development centered

on issues of self-awareness and social-awareness (Danko 2003). They are useful tools that provide designers with insights as to how space users may feel before architectural spaces are designed for them. Narratives bring to light past and present subjective experiences that can be shared and compared in order to predict design solutions that may foster user satisfaction and well-being. This story format is powerful in communicating design messages (Danko and Portillo 2001).

Results from both narrative and neuroscientific research methods have been useful in this study in order to prove that peoples' moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit. As most research on user behaviour focuses on expressed and explicit behaviour, using the qualitative method of narrative inquiry to begin with, has helped to delve deeper into the underpinnings of the implicit human response to space, that is, not always expressed by users.

The Model of Human Experiential Responses to Space and the Environmental Comfort Model of User-Space Interaction: the comfort-productivity continuum (Vischer 2005), confirm that setting the right mood for space users while conveying a positive atmosphere (good environment/energy in) will generate feelings of well-being and therefore less stress and adaptation (bad environment/energy out) to spaces they occupy. All participants in the narrative inquiry mention that space characteristics were important to them. One of the participants (1) stated that he disliked one of the offices that he occupied because it was humid and it had bad odours. He said that he felt satisfied with the current office he was in because it was newly built and it had plush materials which added to his comfort level. The office space also had pleasant views to the outside, had an interior garden and was in close proximity to public transport.

Another example can be taken from the neuroscientific study whereby space users participated in both pre- and post-move questionnaire surveys. They were able to express their discomforts regarding environmental characteristics of both the old and new offices.

Results revealed that having taken space user needs into consideration, participants were generally more satisfied with the new offices.

Each of the two studies also served to prove that quantitative data can be used to flesh out and expand the results of qualitative data analysis. The studies contributed to the search for intangible aspects of architectural spaces and how they influence human well-being. Although these were not easy to measure, we were able to elicit information about them through subjective introspection (such as narrative inquiry) and neuroscientific correlates that could be measured using purpose-designed, standardised surveys.

First, 48 environmental characteristics of architectural spaces were found to influence human well-being, then research data and results from the neuroscientific survey provided material that came directly from space users' feelings towards environmental characteristics. They provided useful data that was used to design the new office and measured impacts of interior features on mental processes. Using research data from the old office, plans for the new office were articulated in a way to meet space user needs. In the old office, when employees had to take the building's main elevator lobby core to get from one floor to the other, they did not feel they were part of a cohesive and unified environment. Research results in the old office provided this information beforehand, therefore plans for the new office were designed to have an open central staircase within the office space that joined the three floors. This feature was also meant to enhance employee encounters as they walked up and down from one floor to the other. Coffee stations were also designed close to the stairwell on each floor in order to serve the same effect providing opportunities for employee conversations and acquaintances. This was an effort to create a work atmosphere that was much more conducive to working together and creating the feeling of a unified and cohesive organization.

Research results from data derived from office employees in the old office provided designers essential information which they used to design the new office. This also added value by going beyond initial design program requirements. Data that came directly from

space users helped to better understand and respond to a collective voice, that went beyond a traditional list of client's needs.

The not so obvious, subjective or qualitative data are just as important and useful as empirical, quantitative data. Beyond what is obvious are the hidden subtleties that often become the most important architectural elements in a space. Just like the yin and the yang combine to create a balanced entity, the visible and the invisible, the negative and the positive, combined are necessary to comprehend the fullness of a space. As shown in the Model of Experiential Responses to Space (Figure 3-1), the intangible aspects of a space, which are composed of multiple environmental characteristics, go beyond simple space planning principles. The voids, the untouchables and invisible components of a space, such as noise or odours, are also present and act as catalysts to support the more obvious, tangible elements of that space. Time and effort must be taken to continue research in order to unveil essential components of architectural spaces: those components that can, or cannot, be seen or touched.

ORIGINALITY AND CONTRIBUTION OF THE STUDY

This research is one of the few that incorporates both narrative inquiry and neuroscientific research in order to fill the gap in the Interior Design Body of Knowledge (Guérin and Martin 2004). Together these approaches provide an elegant methodological framework that offers both subjective data that comes directly from the heart and objective data through systematic ratings of the environment. In the first study 48 environmental characteristics, representing intangible atmospheres, were found to influence human well-being. This refers to the Human behaviour / Built-Environment Interrelationship found in Table 1-1, whereby it can be said that human behaviour is shaped by the built environment. In the second study, environmental characteristics were shown to influence neuroscience concepts of mood, ability to focus attention and stress. Data from this research provided an opportunity to combine research and practice. This refers to the Experience column found in Table 1-1. Data derived from this study provided information for the designer that was useful to design the new offices. Both studies contribute towards understanding what

humans need in order to have a feeling of satisfaction in the environments within which they live and work.

In the early stages of this research, I was often asked if lighting, or color, or materials, or …, could be the subject of study in reference to having an intangible effect on human well-being. I was also asked if it would not be more logical and more feasible to explore a single environmental characteristic in relation to mood and satisfaction which would also keep the scope of study to a manageable size. I felt that single environmental characteristics had already been explored by other authors and that very few holistic approaches to research had been explored. Consequently, I felt that taking a wider approach to the research would better contribute to the interior design body of knowledge.

Typically, social science research looks at the effects of one environmental variable at a time, but research methods are limited when it comes to the interactive effects of the whole environment on occupants. The decision to combine two approaches to research and the holistic impact of indoor environments on space users is unique. Furthermore, there are very few precedents, and this study therefore provides a strong basis for future research. All environmental characteristics put together act upon individuals and not just single light sources or shades of color, or materials alone.

The choice of a holistic approach concerning intangible aspects of architectural spaces as an area of study itself is different, original and contributing since most studies often tend to singular aspects of architectural interiors. The study of color or light (Jones and Manighetti 2008; Knez and Enmarker 1998; Kwallek and Lewis 1990) as well as emotion or perception (Hugill 2005; Jones and Manighetti 2008) in architectural spaces, and how these affect human behaviour are but some examples.

The originality and contribution of this study therefore is that it has taken a wide-angle, holistic approach. The fact is that it is the complex reality of ‘whole’ spaces incorporating all their characteristics that act upon peoples’ temperaments. The Model of Experiential Responses to Space became the unifying source that held all of the elements

together. It provided a framework that shows that architectural spaces are composed of several environmental characteristics, which together, impact user moods that can be expressed as feelings. Since this model is not linear, it has potential to expand further as research continues to evolve around the framework of tangible and intangible environmental characteristics that affect human well-being.

Using a more holistic approach demonstrates that characteristics of architectural spaces do interact to have an impact on users and that they affect a person's mood, satisfaction and long-term well-being. It also shows that data generated through the two research methods provide designers with information that can impact their way of designing spaces for healthier living environments.

This research is original in that the initial 43 categories that were found to correspond to intangible aspects of architectural spaces can be corroborated with the categories set forth for deep healing design principles. As both methods aim at gathering similar data - personal feelings about environmental characteristics gathered through narratives as well as measured brain responses to these spaces – results provide valuable input for designers to design spaces not only for people living with Alzheimer's disease, but for normal people too.

This research is important because, although human feelings are subjective and not always seen as worthy of research, they represent reality for users. In the context of designing an office space, it may seem a long process and an almost impossible task for designers to tend to every employee's needs; but, accentuating the involvement of researchers in the design process may not only help in data collection and analysis, it also provides useful information geared towards human well-being. It is important that a holistic approach be considered where spaces are designed using subjective knowledge emerging from *inside the gut* of space users.

By focussing on brain design principles to find out how participants felt environmental characteristics affected them before and after the design process, this

research also contributes to the nascent field of neuroscience and architecture. As these two fields are merging and hypotheses are being developed to guide further research, the research performed in this study did just that. Data from user surveys allowed the architects involved in the project to assess the consequences of design decisions in early stages of development and present them to the client with data that supported proposals and plans.

The findings of this research are useful to design professionals who wish to carry out research that addresses human welfare, and have value for those who seek to know more about the subject or who wish to pursue further research in this field. This research may also contribute to academic design programs where subjective user needs may become an essential part of the learning process. When learning how to design environments for space users, it is important to know that humankind can evolve in finding out what is right for a harmonious living environment geared towards user self-fulfillment.

CONCLUSION

Today, design solutions do not habitually tend to each and every individual's needs, especially when there is a large number of employees in an office setting and that costs to do so would make it almost impossible. When employees know that their voices are being heard and that someone is willing to do something to support their personal needs, it has positive effect. As long as the data they provide have been considered and acted upon, employees feel proud. Involving employees to be part of the design process gives them a sense of belonging and allows them to foresee difficulties that lie ahead and understand that some of the characteristics they are hoping for may not always be possible.

Designing today must address the needs of space users directly and as research and practice continue to work together the design body of knowledge will continue to increase. Future researchers will build on this study by testing and adding to the 48 environmental characteristics it has uncovered. These can then be tested in terms of the neuroscientific correlates in order to merge and solidify the findings. If similar environmental characteristics that enhance human well-being can be found using both narrative data and

neuroscientific research and in different settings, this will indicate that specific intangible environmental characteristics can be applied to design.

Further research should also aim at capturing voices of users that not only focus on subjective reality but that augment experiential perspectives on how intangible aspects of architectural interiors influence human well-being. This means that the more subjective data can be collected and analyzed, the more correlations can be found between what space users feel and need. Research that links design and health is a priority since good design is essential for the comfort and satisfaction of space users. It forms the context for peoples' moods and emotions and in turn impacts space users' performance.

Further research is needed to increase the understanding of how people inhabit their living spaces in order to increase their well-being. Research is needed to support designs that promote healthy living and working environments. It should develop designers' understanding of the environmental impact on space users' health and optimize the preconditions of supportive design. Knowledge of design solutions for healthy living environments may be applied in planning, building and evaluating architectural settings.

Even though the knowledge gap that this research refers to lies within the Experience part of the Interior Design Body of Knowledge (Guérin and Martin 2004), it is through ongoing building of research knowledge and ties between design professionals and research groups that practitioners will better understand the advantage of using scientifically based research findings. Through this research, it is hoped that design practitioners will involve more research teams in different stages of their projects so as to capture subjective user feelings that will bring to light issues that inspire design solutions geared towards human well-being. Furthermore, through the publication of articles, the research methods and findings from this research will be accessible to students who may benefit from these ways of accessing human experiential material.

Everyone likes to live in beautiful spaces and everyone likes to enjoy their surroundings, but strangely enough, many people adapt to spaces that they don't feel

comfortable being in. Surprisingly, if the question '*How do you enjoy your surroundings?*' was asked, most people would have lots to say about what they like and dislike about their surrounding, but are rarely given that opportunity. Most often, space-users take their workspace for granted and would rather not grumble about their discomforts. Using narrative inquiry as a method well suited to organizational study and communication, narratives allow people to express their thoughts through story telling where their stories are not seen as complaints but as essential information from which designers can use to better design architectural spaces.

Using a mixed research approach is well suited to, and imperative for studying intangible aspects of architectural spaces. As people's moods and emotions are affected by elements of the space they occupy in ways that are neither direct nor always explicit, both narrative inquiry and neuroscientific research methods reveal implicit material. Together, both methods offer tremendous advancement for interior design as they help organize the complex world of people, entities, and events through both the language of stories as well as through brain responsive tools. Together, they provide a flexible framework for understanding and expanding the meanings of design (Ganoe 1999). Stories are a powerful vehicle for exploring the subjective experience of architectural spaces. Neuroscientific research extends intuitive understanding by showing how our brain is fine-tuned to our environment and how it responds and adapts to information that reaches us through our senses (Zeisel 2006, p 11).

The profession of interior design is defined through the Foundation for Interior Design Education and Research (FIDER) and the National Council for Interior Design Qualification (NCIDQ) standards and association reports (FIDER 2006). However, frameworks can be expanded to encourage designers to articulate and document their experiences regarding designed environments in an accessible form such as narratives (Danko, Portillo et al. 1999; Portillo, Mclain-Kark et al. 1999) and findings confirmed using neuroscientific research (Eberhard 2003, Eberhard 2004, Eberhard 2005, Zeisel 2006). Delving into the realm of intangibles can bring a whole new dimension to the

understanding and experience of interior design, which is the contribution of this research. Researchers interested in the questions of intangibles and how they influence human well-being can use the frameworks found in this study and continue to immerse scientific research and design experience as a way to enrich design practice and further expand the Interior Design Body of Knowledge.

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APPENDIXES

APPENDIX 1 – Building-in-Use Assessment Questionnaire

APPENDIX 2 – Neuro-Environment Assessment Questionnaire – Pre-Move

APPENDIX 3 – Neuro-Environment Assessment Questionnaire – Post-Move

APPENDIX 1 – BUILDING-IN-USE ASSESSMENT QUESTIONNAIRE

(Vischer 2005)

Building-In-Use Assessment Questionnaire

Date _____

Building Number _____ Floor _____ Workstation number _____

You will find in the next few pages, a series of simple questions about your work environment. The questions are mostly in the form of a scale from 1 to 5, in which 1 means uncomfortable and 5 means comfortable. We will analyse your responses to provide a profile of the functional comfort of your work environment, compared to pre-existing norms. This information will be available to you, if you request it.

Please answer every question. Please do not discuss your replies with colleagues until after you have completed the survey. You may return completed questionnaires within 24 hours to the research team, or place them in the box for completed questionnaires located on your floor.

The identification numbers on each survey form are to aid in data analysis. Please note that all individual responses are anonymous and will remain confidential.

Thank you for taking time to complete this survey (we know you are often asked to fill out questionnaires.

Please assess the following aspects of our workspace on a scale of 1 to 5, where 1 means uncomfortable and 5 means comfortable and 3 means neutral. Please check one response to each question.

Temperature comfort:	1	2	3	4	5
	UNCOMFORTABLE				COMFORTABLE
How cold it gets:	1	2	3	4	5
	TOO COLD				COMFORTABLE
How warm it gets:	1	2	3	4	5
	TOO WARM				COMFORTABLE

Temperature shifts:	1	2	3	4	5
	TOO FREQUENT				CONSTANT TEMPERATURE
Ventilation comfort:	1	2	3	4	5
	UNCOMFORTABLE				COMFORTABLE
Air freshness:	1	2	3	4	5
	STALE AIR				FRESH AIR
Air movement:	1	2	3	4	5
	STAGNANT AIR				GOOD CIRCULATION
Noise distractions:	1	2	3	4	5
	TOO DISTRACTING				COMFORTABLE
Background noise levels:	1	2	3	4	5
	TOO MUCH NOISE				COMFORTABLE
Specific noises (voices, equipment):	1	2	3	4	5
	TOO NOISY				COMFORTABLE
Noise from the ventilation systems:	1	2	3	4	5
	TOO NOISY				COMFORTABLE
Noise from lights:	1	2	3	4	5
	BUZZING LIGHTS				COMFORTABLE
Noise from outside the building:	1	2	3	4	5
	TOO NOISY				COMFORTABLE

Furniture comfort in your office/workstation:	1	2	3	4	5
	UNCOMFORTABLE				COMFORTABLE
Size of your office/workstation:	1	2	3	4	5
	UNCOMFORTABLE				COMFORTABLE
Storage space in your office/workstation:	1	2	3	4	5
	INADEQUATE				ADEQUATE
Access to equipment:	1	2	3	4	5
	UNCOMFORTABLE				COMFORTABLE
Personal storage:	1	2	3	4	5
	INADEQUATE				ADEQUATE
Informal meeting space:	1	2	3	4	5
	INADEQUATE				ADEQUATE
Space for collaborative work with colleagues:	1	2	3	4	5
	INADEQUATE				ADEQUATE
Space for meetings with visitors:	1	2	3	4	5
	INADEQUATE				ADEQUATE
Visual privacy:	1	2	3	4	5
	UNCOMFORTABLE				COMFORTABLE
Conversation privacy:	1	2	3	4	5
	UNCOMFORTABLE				COMFORTABLE

Telephone privacy:	1	2	3	4	5
	UNCOMFORTABLE				COMFORTABLE
Electric lighting comfort:	1	2	3	4	5
	UNCOMFORTABLE				COMFORTABLE
How bright it gets:	1	2	3	4	5
	TOO BRIGHT				COMFORTABLE
Glare from lights:	1	2	3	4	5
	UNCOMFORTABLE				NO GLARE
Access to daylight:	1	2	3	4	5
	INADEQUATE				ADEQUATE
OVERALL, WOULD YOU SAY THAT YOUR WORKSPACE HELPS OR HINDERS YOU IN YOUR WORK?					
	1	2	3	4	5
	MAKES WORK MORE DIFFICULT				MAKES WORK EASIER
GENERALLY, HOW SATISFIED ARE YOU WITH THE PHYSICAL ENVIRONMENT IN WHICH YOU WORK?					
	1	2	3	4	5
	DISSATISFIED				SATISFIED

APPENDIX 2

Neuro-Environment Assessment Questionnaire – Pre-Move

Sample item: A feeling the environment might affect				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Colors				
Size of rooms				
Other: *Please list*				
1. Sense of Safety and security				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Security guard at building entrance				
Guests being required to sign in / out				
Fire stairwell doors locked from inside				
Electronic sensor/pass to enter suite				
Restroom security				
Emergency notification / paging system				
Windows that cannot be opened				
Office doors to private offices that block all views in				
Sidelights (small windows) next to office doors				
Glass wall allowing receptionist (on floor 5) to see elevators				
Building entrance removed from sidewalk and street				
Other: *Please list*				
2. Understanding what is expected in the work environment				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Bulletin board in the kitchen				
Separate reception areas on floor 3 & floor 5				
Clear designation of community versus private space				
Procedure for reserving or using a conference room				
Other: *Please list*				
3. Ability to withdraw from co-workers and unwind				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Quality of the lunch room				
Lack of rest area / lounge on certain floors				
Vending machines				
Outdoor courtyard				
Proximity to Dupont Circle park				
Proximity to cafes, Starbucks, and delis				
Closing the door of my own private office				
Other: *Please list*				
4. Wayfinding – knowing how to get where I need to go in the offices				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Hallway configuration				
Windows to the outside in elevator lobbies				
Lack of windows and natural light in office corridors				
Use of elevators required to move between floors				
Three separate office suites on different floors				
Signs / Directories				
Other: *Please list*				

5. Awareness of outdoors and nature				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Building courtyard				
Floor to ceiling windows at elevator lobbies				
Brick paving employed in some interior spaces				
Windows in private offices				
Interior plants				
Access to views or daylight				
Other: *Please list*				
6. Support and comfort for personal and work needs				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Furniture quality, coordination, and finishes				
Ability to bring in personal furniture and lamps				
Fluorescent lighting				
Clutter in shared work areas				
Built-in storage and closets				
Cable and wire management system				
Floor coverings (carpet and vinyl tile)				
Technology (screen, projector, dimmers) in conference rooms				
Windows and natural light in individual offices				
Manually controlled window blinds				
Opportunity to display personal objects in private office areas				
Proximity to metro station				
Individual temperature regulation				
Noise				
Air quality				
Manual versus automatic light switches				
Other: *Please list*				
7. Sense of pride and accomplishment				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
First impression at reception area				
Scientific posters on office walls				
Information kiosk at elevator lobby				
Colors and materials used in offices				
Materials used in conference room and reception area				
Company logo banner at reception desk				
Other: *Please list*				
8. Feeling part of a unified cohesive organization				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Three separate office suites on different floors				
Use of elevators required to travel between floors				
Main entry lobby on 5th floor				
Offices of different sizes and enclosures				
Carpet color changes				
Other: *Please list*				

Thank you for your time.

APPENDIX 3

Neuro-Environment Assessment Questionnaire – Post-Move

Sample item: A feeling the environment might affect				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Colors				
Size of rooms				
Other: *Please list*				
1. Sense of Safety and security				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Security guard at building entrance				
Guests being required to sign in / out				
Fire stairwell doors locked from inside except with key card				
Electronic key card to enter the offices				
Restroom security				
Windows that cannot be opened				
Office doors to private offices that block all view in				
Frosted glass office walls that let others know someone is there				
Receptionist greeting all visitors who get off on the 10th floor				
All offices within a single 3-floor office suite				
Other: *Please list*				
2. Understanding what is expected in the work environment				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Bulletin board in the mail room				
Bulletin board (to come) in the lunch room				
Microwaves centralized in kitchen/lunch room				
Clear designation of community versus private space				
On line reservation system for conference rooms				
Shared office personalization/decoration policy				
Other: *Please list*				
3. Ability to withdraw from co-workers and unwind				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Having the 10th floor lunch room				
Windows in lunchroom				
Kitchenettes on 9th and 11th floors				
Vending machines in lunchroom				
Proximity to Franklin Square				
Distance to cafes and delis				
Closing the door of my own private office				
Other: *Please list*				
4. Wayfinding – knowing how to get where I need to go in the offices				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Hallway configuration				
Windowless elevator lobbies				
Natural light in office corridors through frosted glass office walls				
Central stair to move between floors				
Similar hallway and office layouts on all three office floors				
Plaques with number and name of office occupant(s)				
Floor plan handed out to all new employees				

Conference rooms with name identification				
Other: *Please list*				
5. Awareness of outdoors and nature				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Entering 10th floor with receptionist in front of window				
Special flooring on 10th floor at elevator and reception				
Windows in private offices				
Windows in interior offices capturing secondary daylight				
Interior plants				
Access to views or daylight				
Windows in lunchroom				
Other: *Please list*				
6. Support and comfort for personal and work needs				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Furniture quality, coordination, and finishes				
Availability of an individual office lamp by request				
Ceiling lighting in offices				
Under cabinet lighting at workstations				
Automatic ceiling lighting adjustment in response to sunlight				
Built-in coat closet on 10th floor				
Hook for coats in offices				
Cable wire management system				
Floor coverings				
Technology (screen, projector, automatic blinds) in conference room				
Windows and natural light in individual offices				
Manually controlled office window blinds				
Opportunity to display personal objects in private office areas				
Proximity to metro station				
Temperature regulation in offices				
Noise control in offices				
Availability of an office white board by request				
Air quality in offices				
Other: *Please list*				
7. Sense of pride and accomplishment				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Posters at 10th floor elevator lobby				
First impression at reception area				
Cajal mural in central stair case				
Journal cover posters throughout the office suite				
Literature rack in reception area				
Colors and materials used in offices				
Materials used in conference room and reception area				
SfN logos at 10th floor entrance and reception				
Other: *Please list*				
8. Feeling part of a unified cohesive organization				
How do the following items contribute?	*A lot*	*A little*	*Not at all*	*Has opposite effect*
Main entry lobby on 10th floor				
Central stair connecting all three office floors				
Standardized office sizes and locations				
Standardized office furniture materials and quality				
Equality in computer equipment systems				
Similar carpeting throughout office suite				

Other: *Please list*				

9. And now here are several general questions about your workspace				
	A lot	*A little*	*Not at all*	*Has opposite effect*
To what degree do you feel ***your particular workspace*** helps you in your work?				
Generally, how satisfied are you with the physical environment of ***your particular workspace***?				
To what degree do you feel the physical environment of the ***offices as a whole*** helps you in your work?				
Generally, how satisfied are you with the physical environment of the ***offices as a whole***?				

If you were employed only after the offices moved to the new location, thank you for answering this questionnaire.

If you were employed when the offices were still in the former office location, please take time now to answer this one final set of questions.

10. Only answer these questions if you were employed when the offices were situated at the former location. ***If you were not, that's all.***				
If you were an employee in the previous offices, please think back to that time and answer the following questions with reference to your workspace there and the overall physical environment to those offices.	*A lot*	*A little*	*Not at all*	*Has opposite effect*
To what degree do you feel ***your particular workspace*** at the former office location helped you in your work?				
Generally, how satisfied were you with the physical environment of ***your particular workspace*** *at the former office location*?				
To what degree do you feel the physical environment of the ***offices as a whole*** at the former office location helped you in your work?				
Generally, how satisfied were you with the physical environment of the ***offices as a whole*** at the former office location?				

Thank you for your time.

Note: *The experts involved in formulating the questionnaire items in both Pre- and Post-Move Neuro-Environment Assessment Questionnaires were John Zeisel and Jacqueline Vischer, accompanied by the Executive Director of SfN. They used their knowledge of neuroscience, of environment-behaviour research in offices, and of SfN operations in order to identify features of the office space that could appropriately be attributed to each of the eight brain design principles.*

I