Memory of Design Features in Built Environments

by

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Abstract

The purpose of this study was to identify memory of design features or wayfinding preferences that may be related to gender and ethnicity. This was done in order to assess whether there were any statistically significant differences in memory for design features or wayfinding preferences in the built environment for gender and ethnicity. Findings from this research may help design practitioners make more informed decisions for planning design features and visual landmarks as wayfinding aids in the built environment.

This study investigated memory of design features in the built environment. It also investigated the impact gender and ethnicity had on wayfinding preferences. Procedurally, 129 students at Virginia College in Birmingham, Alabama viewed the PowerPoint slide presentation of an interior environment and completed the survey instrument.

Results from the two-way analysis of variance statistical analysis revealed statistically significant differences between the predictor variable of gender regarding memory of design features in the built environment. Results from the two-way analysis of variance statistical analysis revealed no statistically significant difference between gender regarding wayfinding preferences. There were statistically significant differences between the predictor variable of ethnicity regarding wayfinding preferences. There was a statistically significant interaction effect between gender and ethnicity for wayfinding preferences.

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CHAPTER I. INTRODUCTION

Environmental Cognition

People experience their environment as full and complete, rather than as partial and fragmentary. Acquiring, coding, storing, recalling, and decoding information about the relative locations and attributes of phenomena in our everyday spatial environment is called cognitive mapping (Downs & Stea, 1973; Ozel, 1998, 2007). The better an individual's cognitive map, the more efficient his or her spatial behavior (Lynch, 1960). The process of cognitive mapping is used daily in navigation in the built environment.

Cognitive mapping must be considered a factor in emergency egress behavior during fires. Fire and smoke alter people's perceptions of the environment, and modify the way they process environmental information. These changes are manifested in an increased use of cognitive processes in selecting routes and wayfinding.

Gerald Weisman hypothesizes that to the extent an environment provides perceptual access to either interim or ultimate destinations it facilitates wayfinding (Weisman, 1981). Environments with elements of physical distinctiveness, or landmarks, also facilitate wayfinding. Additional factors that influence the identification of landmarks might be personal or social significance and patterns of activity. A landmark is represented in person's cognitive map to the extent the person has invested it with visual, inferred, or functional distinctiveness.

Of all the environmental variables, signage—the purpose of which is to provide critical choice points along exit ways—is the most widely recognized for the purposes of fire safety. The plan configuration of a given setting is another environmental variable. Fire safety professionals are beginning to accept plan configuration as a factor in emergency egress. Some insurance companies now give discounts for simplicity in building layouts (Canter, 1980. p. 307).

Cognitive Expectancies

Using Gestalt laws of perceptual organization to explain wayfinding behavior and cognitive expectancies, "any configuration is perceived in such a way as to make it appear as simple, clear, or comprehensible as possible." In other words, people try to superimpose on objects properties such as symmetry, regularity, and continuity.

Building plans with these qualities facilitate image building and wayfinding by supporting the creation of better cognitive maps. Discontinuous corridor layouts, such as polygons that do not enclose, complex layouts with concentric corridors, undifferentiated interiors where occupants are unable to orient themselves to the exterior, and slightly irregular layouts interfere with wayfinding behavior (Passini, 1984).

Environmental Variables

The following environmental variables play a role in environmental cognition: visual access to other areas of the building, physical or functional differentiation of building parts, signage for identification and direction purposes, and plan configuration (Weisman, 1979). Even though the environmental research in the built environment began with architect and researcher Kevin Lynch's Image of the City (1960), terminology of wayfinding did not begin until later. The initial use of the term "wayfinding" did not appear until the research of Downs and Stea (1973). This research on the effect wayfinding has on cognitive and decision-making processes helped to push wayfinding into the forefront of environmental and behavioral research (Singer & Ritz, 1996).

Information-processing theory assumes that the human information-processing system consists of three functionally distinct kinds of memory systems: the sensory registers, working memory, and long-term memory. Sensory memory is less than one second, has an automatic decay, interference or displacement and there is no control on the form of representation. Working memory has limited capacity. There is completion based on this limited capacity, typically seven slots or units. Working memory typically decays if 15 seconds if not rehearsed. Coding for working memory can be verbal, visual, or semantic. The person has control on the form of representation. In long term memory, the capacity is unlimited. Once stored the information is never erased although retrieval could be difficult. There is semantic representation as well as form, sound, odor, taste, etc. There is memory for facts and procedure. Information is organized but flexible (O'Connor & Proulx, 2004). Environmental cognitive factors and design features related to this cognition in the built environment contribute to the design of built environment specifications and wayfinding systems.

Wayfinding Model

Wayfinding can be divided into three different processes based on the model suggested by Passini (1980). These processes include 1) cognitive mapping or information processing, 2) decision-making process, and 3) decision-execution process. In the cognitive mapping process, information is retrieved and developed by individuals in the built environment. In the decision-making process, people plan and structure wayfinding strategies. In the decision-execution process, people transfer decision into action (Chen & Stanney, 1999).

Much research on life safety suggests that the decision-making process is one of the most critical (Bryan, 1981, 1983; Proulx, 2002). Theories about wayfinding and how spatial information is processed have been an important part of design and fire safety literature.

Assumptions concerning the emergency egress behavior patterns of building occupants have been incorporated into design and regulatory processes, such as provisions for occupant density, dead end corridors, and adequate number of exits (Stahl, 1979).

In general, wayfinding in buildings has been seen as a perceptual problem; for example, it is assumed that a fire provision such as a fire door, if present, will be seen and used by occupants. However, fire safety literature appears to contradict a perceptual approach (Bryan 1981; Canter, 1980). Building egress systems can often be complex and non-intuitive to users. Research has shown the benefit of appropriate signage for wayfinding. Designers should not overlook this important aspect of ensuring occupant safety, especially in complex commercial buildings (Proulx, 2002)

Environmental research literature provides ample evidence that most people have difficulty with spatial orientation—even when they are familiar with a building—because of the increasing complexity of the built environment. Signage and related information in buildings do not overcome users' problems with spatial orientation and wayfinding.

These results have been confirmed in a range of facility types, including nursing homes, shopping malls, and hospitals (Hunt, 1981; Passini, 1984; Bryan, 1981, Ozel, 1998, 2007). Similar results also have been observed under fire conditions (Bryan, 1981; Edelman, 1980, Ozel, 1993, 2007). A few studies have tried to examine the effects of environmental stressors, such as noise and fire emergencies (Evans, Skorpanich, Garling, Bryant & Bresolin, 1984; Ozel, 1986, 1998) on environmental cognition and route selection.

Cognitive Factors and Codes

Regulations, restrictions, laws, zoning, codes, and other enforceable mandates impact our environment, buildings, products, and behavior. Many of these controls are used to good effect, but some rules, meant to protect, restrict positive outcomes and behaviors. Design professionals seek to suggest creative alternatives and explore the value of design thinking across the physical, social, and cultural landscape (Arizona State University, Phoenix Urban Research Laboratory, 2007).

Environmental cognitive factors and properties of the physical environment that contribute to the formation of more accurate and complete cognitive maps must be incorporated into in the emergency egress performance specifications. Because it is neither practical nor possible to list all building configurations, materials, and all surface finishes that promote better wayfinding and orientation, it may be necessary to specify the performance of buildings for wayfinding.

We must develop specifications that reflect the combined effect of building features on emergency egress and wayfinding processes. Cognitive accessibility can be a key measure of such performance. Just as we can specify a 4- or 3- for our fire resistance-rated wall, we can specify the amount of time that building occupants will need to locate an exit for safe egress (Ozel, 1998, p. 69).

Disability demographics estimate that approximately 17.47% of the population of the United States experience some form of disability including physical and cognitive impairments (U.S. Census Bureau, 1997; 2000). In other words, 246,099,000 people in the United States are in some disability group. As design professionals and practitioners, it is imperative that we address these issues in the built environment.

It is understood by building and design professionals that a proportion of the building population may be impaired on a permanent or temporary basis. Therefore, the design of the structure takes into account such impairments but more knowledge is needed in the area of cognition in the built environment. This growing diverse market may need modifications to its physical environments. There is increased need for more information on the effect cognitive behavior has on the built environment. Individuals wanted ease of navigation in interior environments. The research cited suggests that landmarks or points of reference in design features and wayfinding may affect people daily and throughout their lifetime. Thus, improving the conditions of interior environments may help improve the quality of life.

Statement of the Problem

The body of existing research is inconclusive regarding gender and ethnicity differences in wayfinding memory. Interior environments may have inadequate wayfinding systems that are based on difficult-to-remember visual and spatial landmarks. Memory levels of visual cues in wayfinding are thought to be important in wayfinding effectiveness. The types and quantity of visual cues needed for safe navigation may vary by a number of factors including gender and ethnicity. The focus of this research is the lack of information related to memory and wayfinding in built environments based on gender and ethnicity.

Purpose of the Study

The purpose of this study will be to identify memory of design features that may be related to gender and ethnicity. Findings from this research may help design practitioners make more informed decisions for planning visual landmarks as wayfinding aids.

Research Questions

This research was conducted to respond to the following research questions:

1. What are the demographic characteristics of individuals enrolled in Applied Health, Business Administration, Computer Aided Drafting and Design, Computer Animation and Game

Design, Design Visualization, Interior Design, Legal Studies, Nursing, and Web Design and Development?

2. What are the frequency and percent of responses for all participants on memory of design features?

3. To what extent are there differences on memory of design features in the built environment based on gender and ethnicity?

4. What are the wayfinding preferences based on gender and ethnicity?

Statement of Hypotheses

To respond to research question three of the study, a null hypothesis, was tested at the .05 level of significance. HO1: There is no statistically significant difference in mean scores for memory of design features in the built environment based on gender and ethnicity,

Definitions of Terms

Aging: A process that begins at birth and involves biological, psychological, and social changes of development and growth over a life span.

Built environment: The built environment encompasses any area in which humans have altered the natural design. The built environment includes all areas altered by humans, whether purposely or merely accidentally. Buildings, homes, gardens, streets, golf courses, and even parks are all considered the built environment. Damage to the environment due to technology and waste is inclusive to this concept (Portillo & Rey-Barreau, 1995). The built environment comprises urban design land use and the transportation systems and patterns of human activity within this physical environment (Davis, 1949).

Cardinal cues: A cue used in navigation that uses either cardinal numbers such as 1, 5, or 15 or cardinal points such as North, South, East, and West.

Cardinal numbers: A cardinal number such as 1, 5, or 15 that is used in simple counting and that indicates how many elements are used in an assembly.

Cardinal points: Cardinal points such as North, South, East, and West.

Cognitive expectancies: The process of expecting objects to have simpler, symmetrical, more regular and continuous configurations due to the misconceptions created by the Gestalt laws of perception. (Ozel 1998, 2007)

Cognitive mapping: Acquiring, coding, storing, recalling, and decoding, information about the relative locations and attributes of phenomena in our everyday environment. (Ozel 1998, 2007)

Directional cues: Cues that describe the relationship between two points or frames of reference.

Disability: The definition of disability set forth in the Americans with Disabilities Act of 1990 (ADA) does not distinguish between type, severity, or duration of the disability. It states:

"The term 'disability' means, with respect to an individual –

(a) a physical or mental impairment that substantially limits one or more of the major life activities of such individual;

(b a record of such impairment; or

(c) being regarded as having such an impairment." (P.L. 101-336, Sec.)

Disorientation: The inability to recognize surroundings or destination; a state of confusion.

General memory: The overall recall of interior architectural and design features that may be useful in wayfinding. (i.e., remembering an object rather than specific characteristics of that object, such as remembering "window" rather the size or shape of the window).

Gestalt: A synthesis of separate elements of emotion, experience, perception, etc. that constitute more than the mechanical sum of parts (Ozel 1998, p. 70).

Gestalt Laws: Law that govern the synthesis of what we perceive. According to the laws of Gestalt, people tend to perceive things in a simplified, regularized, and continuous manner, that, they expect things to possess such properties. Thus, objects whose actual properties slightly vary from these may be mistakenly perceived to have such attributes (Ozel 1998, p. 70).

Hometown region: The area of the country where the participant lived the longest and considers "home."

*Landmark*s: An object must be part of a spatial relationship to be considered a landmark. Landmarks are defined in relation to another object or frame of reference (Blades, 1989; Presson & Montello, 1988). Landmarks serve as a frame of reference because one's senses register spatial configuration. Landmarks are spatial anchors because they provide precise information about location. Landmarks may include primary and secondary references, signage, building configuration, floor plan complexity, lighting, and color-coding. A primary landmark is always present (such as stairs or an escalator). A secondary landmark is not always present or encountered.

Memory: The capacity or process of recalling or remembering facts and experiences previously learned.

Memory levels: The quantitative levels of recall of interior architectural and design features that may be useful in wayfinding.

Mobility: The ability to move from one position to another in the environment**.**

Older adults: Individuals who are aged 60 or older.

Orientation: The knowledge of one's distance and direction relative to objects and places observed or remembered in the surroundings and keeping track of these objects and places as they change during locomotion (Blasch, 1999).

Route Descriptions: Route Descriptions guide the reader on a mental tour using left, right, front, and back terminology (Schneider, 1999).

Spatial Behavior: Any behavior that requires a person to relate to his or her physical environment. Behaviors can be physical actions, such as movement, or nonactions, such as orientation—that is, knowing one's directions and locations in space (Ozel, 1998, p. 70).

Specific memory: The detailed recall of interior architectural and design features that may be useful in wayfinding (i.e. a more detailed description of the feature—the color, texture or shape of a chair).

Survey Descriptions: Survey descriptions present a bird's-eye view, relate new landmarks to known landmark locations, and use terms such as north, south, east and west (Schneider, 1999).

Wayfinding: The spatial behavior that involves the "ability" to move between locations. Wayfinding is the traffic management system, navigation routes, or orientation in and around objects, people, or spaces. Wayfinding means knowing one's location, knowing one's destination, following the best route, recognizing the destination, and finding one's way back out (Carpman, 1993). For the purposes of this study, think of wayfinding as "finding your way" in an environment.

Wayfinding systems: Route navigation plans that use environmental memory aids such as visual landmarks, signage, you-are-here maps, spatial layout, directional cues, lighting, and color-codes.

Wayfinding preferences: Architectural and interior features that are used regularly as wayfinding aids.

Younger adults: Individuals who are between the ages of 16 and 30 years.

Methods and Procedures

Population and Sample

Approximately 150 adults were invited to participate in the study, which was planned for April, 2008. Participants for this study were students enrolled at Virginia College in Birmingham, Alabama. The study began after it was approved by the Institutional Review Board (IRB) at Auburn University, Auburn, Alabama (see Appendix A for approval), and by Virginia College, Birmingham, Alabama.

A convenience sample of college students enrolled at Virginia College in Birmingham, Alabama, was recruited for the study. Students enrolled in Applied Health, Business Administration, Computer Aided Drafting and Design, Computer Animation and Game Design, Design Visualization, Interior Design, Legal Studies, Nursing, and Web Design and Development were recruited for the study.

Initially, school administrators were contacted and given an overview of the study as well as projected time frame need to collect data. Additionally, a copy of the survey instrument as well as the slide presentation was provided to administration. Course instructors were contacted to request permission to allow their students to participate in the study during a scheduled class time. Course instructors were given an overview of the research at the time the initial request was submitted. A schedule was submitted for the administration of the slide presentation and data collection. This was done in an attempt to reduce any interruption of classroom time and give course instructors a way to plan class activities and lesson plans for the students.

Instrumentation

The instrument for this research included two parts, a slide presentation and a survey instrument. Part I, was the slide presentation that included views of entry and interior corridors. Part II was a survey instrument with three sections that collected data on 1) memory of design features, 2) wayfinding preferences and 3) demographic characteristics of the participants, respectively.

Data Collection Procedures

The investigator introduced the research to each class, and she was present to show the PowerPoint slide presentation and administer and collect the questionnaire. The participants were informed orally and in writing of the following: (a) the objectives of the study, (b) no "best answer" exists and every personal response has its own pros and cons, and (c) no performance task is required (e.g., no one will be graded). Participants were informed that they did not have to participate in the study and could withdraw at any time. The name and address of a contact person was provided should participants have additional questions regarding the research. To insure anonymity, participants' survey instruments were assigned a number and the names of participants were not requested. Participants watched the 5-minute slide presentation, and then they were given the survey instrument to complete.

The survey instrument included three sections. The first section of questions concerned wayfinding memory of design features in the built environment. The second section of questions examined wayfinding preferences. The last section of questions requested demographic data of individuals enrolled in the programs. Blank survey instruments were placed in one box and completed survey instruments in another box.

Data Analysis Procedures

The independent variables for this study were gender, ethnicity and wayfinding preferences. The dependent variable for this study was memory of design features. Data were entered into an SPSS spreadsheet for analysis. Descriptive statistics were calculated for frequencies and percents of memory and wayfinding preferences by gender and ethnicity.

A two-way analysis of variance procedure was conducted to respond to each of the null hypotheses.

Assumptions

The following assumptions applied to this study.

1. A PowerPoint slide presentation provided a realistic view of interior environments and will be a useful research aid for the study of memory and wayfinding preferences.
2. The slide presentation included consistent environmental variables of lighting, ambient temperature, and interior movement in the navigation route.
3. Viewing conditions remained the same for participants in this research.
4. Honesty of the participants' response to the survey.

Limitations of the Study

This study had the following limitations:

1. The study was limited to a convenience sample of college students at Virginia College in Birmingham, Alabama; thus, generalization to a larger population is restricted.
2. The survey is a self-report measure.

Significance of the Study

This study should provide interior design practitioners, interior design educators, architects, and facility planners with a better understanding of gender and ethnicity related differences that may affect memory in wayfinding. Gender related spatial behavior may affect navigation skills. In addition, results of this study should identify wayfinding preferences in built environments. Findings from this research may provide gender and ethnicity specific design strategies for planning interests, including healthcare facilities, large complex buildings, nursing homes, assisted living facilities, and educational environments. Educators may incorporate findings from this research into the interior design classroom.

CHAPTER II. REVIEW OF LITERATURE

Chapter I provided background information and a theoretical framework for this study, statement of the research problem, purpose of the study, research questions, hypotheses, definition of terms, assumptions, limitations, and the significance of the study. Chapter II presented a review of research and literature related to memory of the built environment, prerequisites for wayfinding, memory and interaction of memory systems, object location memory, visual connections, processing speed, memory tasks, the connection of memory and wayfinding, gender differences, age differences, landmarks, environmental complexity, decision making, anxiety, route layout and maps, and the implications of cognition to building codes and life safety. The review of literature contains research-based information on the fundamental aspects of incorporating cognitive expectancies in space planning and design in the built environment. A discussion of landmarks, building configuration and complexity, lighting, color and signage were discussed.

The review of literature was organized into six sections. The first section provided an overview of wayfinding theory in the built environment. Section two provided an overview of memory in the built environment including interaction of memory systems, decision making, object location, visual connections, mental rotation, distance, processing speed and life safety. Section three provided an overview of the relationship between wayfinding and memory including gender differences, age differences, and regional differences. Section four provided an overview of landmarks. Topics included decision making based on landmarks, route layout, maps and use of color. The fifth section included research on the increased need to understand human behavior and cognitive tendencies when designing the built environment. The sixth section discussed the importance of memory on life safety.

Wayfinding Theory

Wayfinding—the ability to learn a route and retrace it from memory—is one aspect of people's cognitive map knowledge which includes all aspects of encoding, processing, and retrieving information about the environment (Blades, Lippa, Golledge, Jacobson, & Kitchin 2002, p. 407). Research highlighting specific aspects of cognitive behavior for the visually impaired emphasizes the importance of spatial tasks on wayfinding abilities in a large and complex environment (Blades et. al., (2002). Blades et al. (2002) indicate that people with visual impairments can learn their way along complex routes after relatively little exposure (p. 419).

From a design aspect wayfinding comprises two distinct elements; spatial organization and environmental communication. The former relates to function, ordering of functions, provisions of facilities and the creation of circulation systems which in effect from the outset set the wayfinding problems users have to solve. The latter refers to the environment as an information system, i.e., the graphical and architectural articulation of information which is necessary to solve the wayfinding problem. (Proulx, 2000, p. 103) Application of wayfinding principles can significantly impact a building's design if done in the initial design stages of programming and construction (Robertson, 2001). Raising the awareness of wayfinding in all the stakeholders is critical to design implementation. Robertson and Dunne (1998) suggest that there are insufficient wayfinding aids in public buildings. Their findings indicate that "wayfinding should be integral to the design of new buildings and postoccupancy evaluations should be made to ensure that these aids have been included" (Robertson & Dunne, 1998, p. 2).

Research suggests that a variety of factors affect wayfinding. External factors include the environmental characteristics of primary (e.g., floor level changes, signage, floor plan complexity) and secondary landmarks (e.g., drinking fountains and color schemes). Situational factors also may affect navigation. Situational factors are environmental conditions that affect the wayfinding route. Wayfinding characteristics differ based on each individual's ability to navigate well. These characteristics are the individual traits inherent to people of all ages. A person's sense of direction and familiarity of the environment may also contribute to the success of wayfinding strategies. Cornell, Sorenson, and Mio (2003) indicate that "people readily summarize their ability to remember routes and comprehend their surroundings in terms of a sense of direction" (p. 423). Inherent memory and memory of the navigation route also play a role in successful wayfinding.

Wayfinding is a spatial behavior that requires the ability to move between locations while maintaining orientation in and around objects, people, and spaces. Wayfinding may be thought of as "finding one's way" in an environment. The negative effects of getting lost have physical, emotional, and practical dimensions. Negative physical effects may include eye blinks, rapid pulse rate, and elevated blood pressure (Yaezawa & Yoshida, 1981; Zimring, 1981). Emotional effects may include anxiety, stress, and feelings of helplessness, often leading to frustration and hostility (Malkin, 1991). The practical aspects of getting lost include missing an appointment, having to reschedule, and taking time off from work, in addition to a considerable amount of staff time required to direct or lead people to their destinations (Malkin, 1991). Inadequate wayfinding strategies cost society time and money.

Prerequisites for Wayfinding

Behavioral scientists Garling, Book and Lindberg (1986), Passini (1980), and Zimring (1981) have shown that there are three prerequisites for successful wayfinding. These three prerequisites are (a) degree of differentiation, (b) visual access, and (c) complexity of spatial layout. The first prerequisite, degree of differentiation (i.e., sameness vs. variation) of interior spaces affects a person's ability to recognize those spaces and use them as landmarks. Garling believes that mechanisms of attention for wayfinding involve voluntary and involuntary attention to the environment. These mechanisms may affect the degree of differentiation in wayfinding routes. Involuntary attentions are based on user interest, whereas voluntary attentions are based on user effort in navigation (Garling, 1986).

The second prerequisite for effective wayfinding is visual access to spatial layouts. Visual access may be thought of as being able to see more than one part of the building, such as a view of a lobby, atrium, and bridge from a corridor. Visual access enables a person to maintain a point of reference while wayfinding. Carpman, Grant, and Simmons (1984) studied wayfinding in relation to the comfort and endurance of hospital visitors. These researchers designed a test to determine how long people can go without a graphic sign before feeling uncomfortable during wayfinding. They discovered that people began to feel uncomfortable approximately every 50 feet in a corridor and look for another wayfinding sign. Many aspects of these findings were incorporated into building codes for travel distances for life safety in the built environment and "line of sight" expectations in exit signage.

The third prerequisite for effective wayfinding is understanding the complexity of a spatial layout. The complexity of spatial layout may be defined as the number of possible routes to a destination and the frequency of intersections, jogs, and angles within the route. Weisman

(1981) determined that the simplicity level of a floor plan was a strong predictor of reported wayfinding effectiveness. This researcher also concluded that legibility of signage was the most important component of wayfinding. Golledge, Smith, Pellegrino, Doherty and Marshal (1985) and Kaplan and Kaplan (1983) studied the implications of landmark destinations, mechanisms of attention focus, and art images on wayfinding. These researchers believed that there are similar criteria for effective wayfinding mechanisms of attention. For example, they believed that principal circulation corridors should be free of distractions (e.g., artwork, bulletin boards, confusing graphics) and contain only visual cues helpful for wayfinding. In addition, they believed that signage, when paired with art images, is more effective than confusing graphics in commanding attention and may be interesting enough to be noticed involuntarily.

Types of Wayfinding

Passini (1984) also distinguished among different types of wayfinding such as recreational, resolute, and emergency wayfinding. Recreational wayfinding is distinguished by amusement and relaxation. Resolute wayfinding is done with a purpose of mind. Emergency wayfinding is navigation in times of distress. Of the three types of wayfinding, emergency wayfinding may be the best indicator of behavior. Sime (1980) determined that emergency routes should be the same as familiar entry routes because in panic conditions people always choose the familiar route to escape.

Memory and Interaction of Memory Systems

Gerald Weisman (1979) hypothesizes that to the extent an environment provides perceptual access to either interim or ultimate destinations, it facilitates wayfinding. Environments with elements of physical distinctiveness, or landmarks, also facilitate wayfinding. Additional factors that influence the identification of landmarks might be personal or social significance and patterns of activity. A landmark is represented in a person's cognitive map to the extent the person has invested it with visual, inferred, or functional distinctiveness.

Kuipers (2000) proposes that representation of locations in a spatial environment is separated from one place to the other. Janzen (2006) concurs with this proposal but provides evidence for a memory system representing route direction that is separate but interacting with a memory for object location (p. 506). Janzen noted,

> "In short, three main results were obtained from the experiments. First, objects located at decision points are recognized faster than objects in other places. Second, an effect of route direction can only be evoked at decision point objects, regardless of whether a turn was made or not. Third, the results can be replicated with a subliminal priming method, where the prime object is masked and therefore not consciously available. An impact of strategic processes can be ruled out. It can be concluded that the present experiments provide evidence for a distinct representation of object location and route direction and specific interaction of both memory functions dependent on the specific relevance of a spatial location for wayfinding." (p. 506)

Object Location Memory

Object-location memory in the built environment is basically remembering where things are in the interior environment. Object location memory is frequently needed in many our daily-life activities King, Trinker, Hartley, Vargha-Khadom & Burgess (2004) p. 1340). Some studies claim a minimal age-related decline. In line with the presumed automaticity, more recent work has demonstrated an important reduction with age (Arbuckle, Cooner, Milne & Melchior, 1994) Regardless, object location memory perception in the built environment throughout the lifespan (Arbuckle et al., 2004).

Importantly, object-location memory typically relies on both target aspects of memories, as well as on contextual aspects. Objects or object identities (i.e. target information) can be distinguished from the background context (i.e. the spatial reference frame) which codes their positions. In memory, the two information elements need to be bound together in order to allow efficient performance. Without doubt memory binding is a rather complex achievement of the human cognitive system (Chalfonte, Verfaellie, Johnson, & Reiss, 1996). As such, object-location memory directly connects to episodic memory, i.e. memory for personal events (King et al., 2004, p. 1340).

Postma, Jager, Kessels, Koppeschaar and van Honk (2004) state that certain aspects of route learning and the processing of metric information in object location memory tend to favor men (p. 32). Honda and Nihei (2009) suggest that the female advantage to object location memory is limited to immediate detection of changes (p. 237). McGivern, Mutter, Anderson, Wideman, Bodnar & Huston (1998) suggested that females have an advantage in attention to location but also in recognition of visual stimuli. Postma, Izendoorn, and De Haan (1998) suggest that males may be better than females in the encoding of precise positional information but not in the assignment of objects to positions nor in their integration (p. 344). Eals and Silverman (2007) indicate the men score higher on a test of three dimensional rotation and women score higher than men on a test of object location memory.

Visual Connections

A problem still being explored in wayfinding research is the influence of out-of-sight objects and locations on wayfinding success. Kitchen and Freundschuh (2001) suggested that it may be possible to make decisions based on universal knowledge of out-of-sight objects and locations and past experiences. Line-of-sight views and a connection of visual points along a route may help the traveler make navigation decisions.

Research by Montello and Pick (1993) indicated that route learners can integrate their experiences within a configurational representation of a space, even when distant landmarks or regularities of layout are not visible from separate routes. Similarly, Riesner, Pick, Ashmead, and Garing (1995) believed that sighted travelers use their experiences with optical flow (the relationship between paths of light and vision) in navigation to help pinpoint and keep track of locations not yet visible in the direction of movement.

Processing Speed for Memory

The speed of processing information could be a major factor in the human ability to recognize places and landmarks. Rayner and Pollatsek (1992) determined that stationary objects are quickly identified and localized. In the absence of landmarks, most routes are remembered by the familiarity of spaces as they are encountered. Cornell, Heth, and Alberts (1994) suggested that the strongest memories of these objects occur when the path is viewed in the original direction of travel. Sime (1980) determined similar results for wayfinding memory. Proulx (2002) indicated similar results for cognitive and physical tendencies in evacuation research. O’Connor and Proulx (2004) suggests “people tend to move in a familiar direction rather than experiment new routes during an emergency.”

Williams (2001) suggested, “Cognitive impairments can affect memory and sense of orientation” (p. 11). William also indicated that well-organized space plans, effective use of color, and color-coding may assist recall and prevent injury for wayfinding in the built environment. These findings reinforce the increased need for design knowledge of memory recall and human behavior in the built environment.

Memory Tasks

Goede and Postma (2007) indicate that females have a better memory for object locations, when looking at the overall object memory scores. However, when comparing object identity memory and object-location binding in isolation, no female advantage was found. The overall object location memory scores are based on explicit as well as implicit retrieval of both correctly and incorrectly recognized objects. As such, it might suggest that women can better associate objects with locations or simply retrieve locations, independent of object identity memory (p. 240).

McBurney, Gaulin, Devineni, and Adams' (1997) findings, however, indicate that females outperform males on the memory task (p. 169) while males perform better than females on the mental rotation task (p. 170). As suggested previously, Eals and Silverman (2007) indicate the men score higher on a test of three dimensional rotation and women score higher than men on a test of object location memory.

Wayfinding and Memory

There is a long history of research on memory. However, Kirasic (1999a, 1999b, 1999c, 1999d) suggested that more research of memory in relation to wayfinding may be necessary. The body of knowledge of research on wayfinding memory does have gaps. Research is inconclusive on gender and age effects relative to cognitive function (i.e., memory) in wayfinding. Birren and Schaie (1985) believed,

> By measuring cognitive speed and memory, cognitive function in elderly persons can reliably be assessed. Cognitive speed, consisting of attention span and processing speed, is the most sensitive measure of memory. Age related cognitive decline first manifests itself by a decline in attention span and processing speed. (p. 475)

Salthouse (1988) believed that “in older adults, memory remains relatively intact until late stages of cognitive decline, whereas cognitive speed declines more rapidly” (p. 452). Orencia, Bailey, and Yawn (1993) suggested that the accelerated increase in cardiovascular disease at old age starts some 10 years later in women than in men. This delay is reflected by the difference in life expectancies between men and women.

There is also research to suggest that reduced cognitive function may result from lack of education. The “brain reserve capacity theory” states that subjects with less cognitive function—that is, less brain reserve capacity—are more likely to surpass the threshold beyond which cognitive decline becomes clinically apparent (LeMoal, Reymann, & Thomas, 1997). However, Exel, Gussekloo, DeCraen, Van Der Weil, Houx, Knook & Westendorp (2001) believed that women have a better memory of wayfinding landmarks than men, even when they have less education. Limited education alone, therefore, may not explain the differences in memory of men and women. Exel et al. also suggested that even marital status does not explain the gender differences in memory. Bretler, Claus and Grobbee (1994), Kilander, Nyman, and Boberg (1997), Snowden, Greiner, and Mortimert (1997), and Hofman, Ott, and Bretier (1997) all suggested that arteriosclerosis causing subclinical, ischemic events in the brain contribute to memory or cognitive decline at old age. Additionally, Orencia, Bailey, and Yawn (1993) believed that the accelerated increase in heart disease in older adult men could be a factor in memory decline.

Gender Differences

Previous research points to the need to clarify the effects of gender on navigation effectiveness in the built environment. According to Passini (1998), some disagreement exists among researchers concerning the types of information used in the wayfinding process by men and women. Passini suggests that there is a similar wayfinding thought process for both men and women. Lawton and Morrin (1999), however, suggest that wayfinding differences are due to gender. For example, Lawton (2001) described wayfinding issues concerning gender differences in direction-giving and wayfinding spatial behavior.

These issues include orientation, sense of direction, and use of landmarks. Lawton (2001) stated that gender differences in spatial skills may have implications for everyday cognition in real-world environments. For example, gender differences in perception of spatial relationships may affect the strategies used by women and men in finding their way in unfamiliar environments or the types of information they relay when giving directions to others. Previous research suggests that women tend to have better memory of visual landmarks while men more often remember directional and cardinal tools (Freundschuh & Kitchen, 2001; Kirasic, 1999c).

Gender Differences in Object Location Memory

Iachini, Sergi, Ruggiero and Gnisci (2005) tried to extend the results about gender differences in object location memory obtained in laboratory settings to a real 3-D environment. Our specific purpose was to further distinguish the processing components involved in this kind of memory by considering the strategies underlying the performance. Postma and De Haan (1996) proposed that spatial memory is based on three components: processing of *what* information; of *where* information, and on their integration; and to Siegal and White (1975) whose model suggests that spatial memory may be organized into three kinds of representation: landmark, route, and survey. Iachini, Sergi, Ruggiero and Gnisci (2005) argued that the processing of *what* and *where* information should be related to these three kinds of representation. The possibility of gender differences, therefore, was investigated by taking into account these distinct processing components and kinds of information (p. 57).

Iachini, Sergi, Ruggiero and Gnisci (2005) found no female advantage in recalling information about individual related objects and about categorical spatial relations. James and Kimura (1997) and Kimura (1996) suggest that females are particularly good in tasks requiring mainly the processing of object characteristics. Both object recognition and categorical spatial relations make object identity information and important cue and could explain the absence of gender differences (p. 57).

Voyer, Postma, Brake and Imperato-McGinley (2007) revealed the “presence of significant gender differences in object location memory and object identity memory that were in favor of women under most circumstances” (p. 35). However, in contrast, in terms of masculine objects and distance, findings were in favor of men.

In accordance with Postma et al. (1998), Iachini et al. (2005) found no gender differences in the recall of absolute distance, a measure which implies both metric positional encoding and object to position assignment. This confirms that females and males are equally efficient in the integration of what and where information about single, unrelated objects, and it is also in line with data showing no gender differences in the recall of landmarks (Ward, Newcombe, & Overton,1986) and in the estimate of distances and directions to landmarks (Golledge, Doughtery, & Bell, 1995).

Instead, when the recall of metric information is concerned with spatial relations between objects, a clear male advantage emerges. This ability is implied by route knowledge of the environment and may underlie the male preference for the route strategy in navigation, as shown by (Galea & Kimura, 1993; McGuinness & Sparks, 1983).

Age Differences in Memory

Ambrose (2000) believed that there may be differences between older adults and children's uses of environmental concepts to establish and maintain orientation. The aging population may have multiple needs for wayfinding aids because of increasing visual and mobility needs. Based on studies by Wilkniss, Jones, Korol, Gold, and Manning (1997) and Barrash (1994), a decrease in route learning may occur with age. The researchers determined that older adults made four times more mistakes than younger adults during wayfinding. Thus, additional wayfinding cues and improved navigation systems in buildings may need to be provided due to memory, mobility, and vision losses. Studies by Kirasic (1999b) showed a need for wayfinding improvements in buildings frequented by people of all ages.

As a result of his studies, Kirasic suggested future research focused on ways to identify common processes related to the spatial ability of older adults. According to Kirasic, "One may infer that supplementing or providing multiple sources of spatial information to not only older but also younger adults would positively impact their spatial behavior" (Kitchen & Freundschuh, 2001, p. 171). This recommendation may be especially true for the older adults who tend to show poorer performance on spatial tasks (Kirasic1999a, 1999d). Kirasic also addressed age-sensitive spatial abilities and wayfinding predictors, route information processing, attention span components of navigation, and use of wayfinding cues such as landmarks, maps, and verbal directions (Kirasic 1999a, 1999b, 1999c). Kirasic (1999d) suggested the existence of possible missing links between environmental knowledge and spatial behavior of older adults.

The results of Brabyn's (1999) studies indicated that a variety of gaps exist in wayfinding system plans for older adults. Brabyn suggested there are problems with emergency access, including location of exits and navigation in complex intersections. Additional issues that may need to be addressed are integrating technology for wayfinding into the built environment and developing orientation plans for the elderly and disabled.

Wright, Cook, Webber and Bright (1996) had additional concerns about wayfinding visual mobility. He cited surveys indicating the impact visual impairment had in the United Kingdom. Wright et al. (1996) indicated that the loss of vision may be due to a variety of factors including the loss of some of the visual field, contrast sensitivity, and problems adjusting to changes in light levels. Wright et al. suggested that these eye problems may reduce or affect the usefulness of different kinds of escape route lighting during emergency situations. In emergency escape situations, there may be a need to maximize the search and navigation skills of visually impaired persons, as well as sighted persons, along escape routes. In addition, Robertson and Dunne (1998) had concerns about the quality of wayfinding systems and aids in public buildings. Once in place, some wayfinding systems can be difficult to correct. Ideally, navigation problems are best corrected during the initial stages of design development or soon after construction is completed. Robertson and Dunne's findings suggested that wayfinding should be integral to the design of new buildings and that post-occupancy evaluations of these buildings should be made.

Importance of Landmarks

A benchmark study of environmental cognition by Lynch (1960) emphasized the importance of landmarks in wayfinding. His research findings are an important milestone in environmental cognition theory by wayfinding researchers. Lynch determined that people tend to organize spatial environments in terms of five elements: (a) memorable landmarks; (b) paths people follow; (c) nodes where paths cross; (d) edges of neighborhoods (i.e., generally accepted navigation paths); and (e) socially or physically defined districts in wayfinding. Lynch believed that these well-defined paths and distinctive landmarks help make the environment legible in wayfinding.

Similarly, Passini (1995) determined that wayfinding systems should include all features that are related to the purposeful circulation of people and their ability to orient themselves mentally. When gathering information during the wayfinding process, people who are visually impaired make use of their other senses, (e.g., tactile, auditory, and olfactory), as well as ambient temperature and air movement. How well these environmental factors are perceived will determine whether a building is user-friendly to a visually impaired way-finder. “The critical organizational elements of spatial representations are landmarks and routes. Landmarks are unique visual configurations which are used as course-maintaining aids” (Cohen & Schuepfer, 1980, p. 1065).

There has been much discussion about the development of environmental knowledge, including the biological development of an individual, and its relation to wayfinding. Siegal and White (1975) proposed that environmental learning follows a series of stages from landmark knowledge to route knowledge and finally to survey (i.e., configurational) knowledge. Although one study supports this model (Evans, Marrero, & Butler, 1981), other studies suggest that route knowledge may be acquired prior to landmark knowledge (Garling, Book, Lindberg, & Nilsson, 1981) or even without landmarks (Allen, 1988). Moreover, survey knowledge may already be acquired during the initial period of an environmental learning task (Holding & Holding, 1989; Montello & Pick, 1993). These conflicting findings may lead to the assumption that different information processing systems, rather than one general mechanism, underlie environmental learning. To what extent these processes interact with people and under what conditions are current questions in environmental research.

Environmental Complexity

The relationship between the physical and social environment in which behavior occurs is complex. The situation is complicated by the individual's perception of ambiguous cues, which is primarily influenced by the person's relevant training and previous experience (Bryan, 1983, p. 30). Bryan suggests that tactile and audible way-guidance systems appear to be as suitable as the visible systems in assisting individual movement.

Disabled people may have a variety of limitations that increase their risk in emergency situations: sensory problems, such as deafness or blindness; mobility problems that may entail the need for a wheelchair; and intellectual problems, such as mental retardation (Byran, 1983, p. 23).

Disorientation and stress are linked. Being spatially oriented is so important to many people that when they are lost they become anxious and panicky (Zimring, 1981). Individuals in public spaces are not the only ones who suffer stress when they cannot find their way. Consider the possible casualties when the drivers of emergency vehicles cannot find their destinations. A transplant specimen may not arrive on time or a collision may be caused due to disorientation or anger associated with wayfinding problems. Stress is caused when one loses control of a situation because the environment presents more demands than one can meet at the moment (Pollet & Haskell, 1979).

Emergencies in high-density situations, such as crowding caused by fire or acts of terrorism, require especially safe means of egress, particularly when aging or mentally deficient populations are involved. Considerations need to be given to learning disabilities, including hearing, sight, and mobility impairments, when designing wayfinding plans. In emergency and non-emergency situations, wayfinding systems need to be clear, well-defined, and comprehensible.

Navigation through spaces is an activity people typically do many days of their lives. Thus, by improving navigation systems, one may help to improve quality of life. Previous research suggests that to improve people's quality of life one may need to make modifications in everyday wayfinding systems. There is a growing need for better traffic management systems due to an increasing diverse population, the aging population and visually impaired. Based on studies by Wright, Cook, Webber, and Bright (1996) and Robertson and Dunne (1998), daily wayfinding activities are affected by physical changes due to aging. According to Sime (1980) and Kirasic (1999a), emergency and panic situations may affect person's wayfinding decisions. More recently, terrorist activities have increased the sense of urgency for wayfinding safety.

The design of buildings may be a contributor to or moderator of stress (Pollet & Haskell, 1979, Zimring 1981). A design understanding of spatial behavior and its resulting impact on wayfinding efficiency may be critical to initial design development of wayfinding plans. Psychological effects of design layout, placement of landmarks, signage, lighting, and color in navigation routes may later dictate changes in the environment if errors are made initially. The contributions of memorable design features, including building landmarks, signage, and color-coding, may help eliminate the negative effects of getting lost (Pollet & Haskell, 1979; Zimring, 1981).

Processing Speed

The speed of processing information could be a major factor in the human ability to recognize places and landmarks. Rayner and Pollatsek (1992) determined that stationary objects are quickly identified and localized. In the absence of landmarks, most routes are remembered by the familiarity of spaces as they are encountered. Cornell, Heth, and Alberts (1994) suggested that the strongest memories of these objects occur when the path is viewed in the original direction of travel. Sime (1980) determined similar results for wayfinding memory.

Rayner and Pollatsek (1992) believed that fixed objects or landmarks are more quickly identified and localized. Siegal, Kirasic, and Kail (1978) suggested that acquired knowledge may affect wayfinding in individuals. That is, gender and ethnicity related learned experiences may affect the processing and memory of design features.

Williams (2001) suggested "Cognitive impairments can affect memory and sense of orientation" (p. 11). Williams also suggested that well-organized space plans, effective use of landmarks, and color-coding may assist recall and prevent injury for wayfinding in the built environment

Decision-making

Disorientation and stress are linked. Being spatially oriented is so important to many people that when they are lost they become anxious and panicky (Zimring, 1981). Individuals in public spaces are not the only ones who suffer stress when they cannot find their way. Consider the possible casualties when the drivers of emergency vehicles cannot find their destinations. A transplant specimen may not arrive on time or a collision may be caused due to disorientation or anger associated with wayfinding problems. Stress is caused when one loses control of a situation because the environment presents more demands than one can meet at the moment (Pollet & Haskell, 1979).

Emergencies in high-density situations, such as crowding caused by fire or acts of terrorism, require especially safe means of egress, particularly when aging or mentally deficient populations are involved. Considerations need to be given to learning disabilities, including hearing, sight, and mobility impairments, when designing wayfinding plans. In emergency and non-emergency situations, wayfinding systems need to be clear, well-defined, and comprehensible. Design professionals need to take into account the effect building design features and landmarks have on occupant behavior. Careful consideration and knowledge of cognitive and physical abilities must be made in selection of design features.

A pioneering study of spatial perceptions by Small (1901) explored rat behavior in maze navigation. Findings from related studies of the route choices of children and adults parallel those from the Small study on navigation. Maze navigation studies became popular during the early 1900s and were replicated again by Maier and Schneirla (1935). Results indicated that route choices made in the middle of a maze are learned the slowest. The decisions made by rats at the end of the maze were the earliest learned decisions.

For example, Wilkniss et al. (1997) and Kirasic (1999b) were both in agreement on the issue of wayfinding route choice indicators for gender, age and ethnicity groups. The authors determined that midpoint decisions in the navigation route are hardest to remember. Children and adults also show these similar patterns when learning navigation routes in urban settings.

Cornell, Heth, Kneubuhler, and Sehgal (1996) confirmed the results by Wilkniss et al. (1997) while studying adult and youth behavior in public settings. An example of a practical application of these behavioral findings is that police may use the human tendency to slow navigation at midpoints in a path to capture escapees or fleeing persons.

Anxiety

Lawton and Kallai (2002) reviewed gender differences in wayfinding strategies and anxiety about wayfinding in American and Hungary. Their findings suggest that regardless of ethnicity, women in both countries exhibit higher wayfinding anxiety than men. Women preferred route wayfinding strategies while men preferred orientation wayfinding strategies. Findings indicate “Heightened concern about wayfinding, which in turn may affect women’s sense of efficacy in the physical environment” (Lawton & Kallai, 2002, 399).

According to Seyle (1979), it is recognized that every person involved in an emergency will feel some form of stress regardless of their age, gender, past experience, training or cultural background. This stress is not an abnormal reaction; on the contrary, stress is regarded as a necessary state to motivate reaction and action. The performance of the person in dealing with a stressful situation will depend on the task demands, the environmental conditions and the subject himself or herself. In order to make a decision, the person will process information perceived in the environment or drawn from past experience (Janis & Mann, 1977).

Evans, Skorpanich, Garling, Bryant, and Bresolin (1984) evaluated the relationship between individual cognitive processes and physical properties of the environment. Their findings indicate that “relocation was significantly affected by environment and strongly influenced by stress” (p. 331). The presence of landmarks significantly increased relocation performance in the environment. However, “stress eliminated any advantage provided by landmarks” (p. 331).

Wayfinding decision-making during an emergency is different from day-to-day decision-making for three main reasons. First, there is much more at stake in emergency decisions—often the survival of the person and of the people he or she values the most is at play. Second, the amount of time available is limited to make a decision before crucial options are lost. Third, the information on which to base a decision is ambiguous, incomplete and unusual, further it is usually impossible to look for more appropriate information due to the lack of both time and means to get information (O’Connor & Proulx, 2004).

Emergency wayfinding decisions differ greatly from decision-making on normal everyday activities. Decision making under stress involves a variety of factors including hypervigilance, narrowing of attention, attempts at controlling the process, information overload, and ineffective decisions. The normal capacity for working memory is typically seven units of information and in times of stress that is reduced to two or three units. There is typically limited information on which to base decisions in a limited time frame (Miller, 1994; Sime, 1980). Based on these findings, it is suggested that design features in the built environment, particularly in exit routes be clear, defined and unambiguous (Proulx, 2002; Cornell et. al, 2003)

Gender Differences in Wayfinding

Research by several authors of wayfinding texts suggests that age and gender affect wayfinding. The texts by Carpman and Grant (2001), Malkin (1991), Bechtel (1997), and Golledge (1999) are popular references for scholarly research, including wayfinding. Examples of effective wayfinding are described and illustrated by these authors. Their research procedures include site visits, problem analyses, photo surveys, architectural critiques, consultations with artists, and discussions with graphic and signage consultants. Bechtel's (1997) *Environment and Behavior* is a compilation of his research on the psychology of the environment that spans over 40 years.

Interestingly, women tend to be more accurate than men remembering landmarks, including their locations. Women also appear to have an advantage identifying objects in an array of shapes whose locations have been changed (Eals & Silverman, 1994; James & Kimura, 1997; McBurney, Gaulin, Defineni, & Adams, 1997). Women's memory advantage in wayfinding has also been determined in placement of a map of objects previously seen in a room (Montello, Lovelace, Golledge & Self, 1999) and recall of landmarks and street names from a map (Galea & Kimura, 1993). Lawton and Morrin (1999) suggested, however, that men remember out of sight landmarks more readily than women.

Lawton, Charleston and Zieles (1996) found gender differences between reaction times to visual danger and wayfinding accuracy. In pre-history, spatial awareness and reflex action could determine survival. Many of the gender differences seen in spatial cognition may have evolved as a result of cultural roles given to men and women. According to McBurney et al. (1997, as cited in Kitchen & Freundschuh, 2001), “Sex differences in spatial abilities are said to have evolved as a function of the historical division of labor with males in most cultures assuming primary responsibility for hunting activity, and females for gathering food” (p. 198). Other authors had similar findings on spatial cognition. For example, Geary (1996) suggested that men developed an understanding of geometric spatial relationships as a result of their hunting activities. He also determined that gender differences in children’s wayfinding are due to expected gender goal structures. Geary suggested that wayfinding stereotyping of children may affect their wayfinding development. Gender expectations, as well as the types of activities children perform, may be a factor in wayfinding performance. Differences between men and women may serve as a foundation for cognitive mapping and wayfinding behavior in later years. Nordvik and Amponsah (1998) studied gender differences in college students’ spatial abilities and spatial activities. Men scored higher than women on tests of spatial cognition. It is important to note, however, that gender differences are reflected more in leisure activities than in education and work activities (Kitchen & Freundschuh, 2001). Kitchen (1996) suggested that these gender differences may need more research.

Previous research also suggests that stereotyping may be a factor in gender performance of spatial tasks. For example, Harris (1981) suggested that environmental wayfinding is stereotyped as masculine. Similarly, women are more uncertain in wayfinding activities classified as *masculine* (Harris, 1981). Other research (Beyer, 1990; Schmitz, 1997) parallels these observations. Beyer (1990) proposed that women tend to underestimate their performance on spatial tasks that are cross-gender typed.

Schmitz (1997) studied gender related wayfinding strategies of children aged 10 to 17 years. Results indicated that boys utilize maps and written descriptions for directions in contrast to girls' utilization of landmarks. These landmarks include color, signage, and building configuration. Individual differences often override gender differences. Miller and Santoni (1986) and Brown, Lahar, and Mosley (1998) explored gender differences in direction-giving. Both studies examined landmarks, cardinal cues, and relational cues when using maps. Men and women did not differ significantly in overall wayfinding strategies or in completion time for wayfinding tasks. Interestingly, females, especially middle-aged women, gave more wayfinding directions to other way-finders. Middle-aged women gave more wayfinding directions than any other age group.

Lawton et al. (1996) studied gender differences in indoor wayfinding and measured incidental learning in an unfamiliar environment. Results of this research showed no significant differences in completion times or in wayfinding patterns. However, men were significantly more accurate in indicating direction within a space. Brown, Lahar and Mosley (1998) study reinforced Lawton's conclusions of gender differences. Additionally, Brown et al.'s research suggested that women were less accurate in wayfinding strategy for wayfinding only when using directional indicators or relational cues (e.g., decisions in relation to two or more objects).

Memory research in wayfinding is inconclusive, notably in the area of building layouts. Dabbs, Chang, Strong, and Milun (1998) suggested that men are more knowledgeable than women in terms of wayfinding geography behavior. However, Kitchin (1996), Golledge, Montello and Self (1993), and Golledge, Doughtery, and Bell (1995) found very few gender differences in geographic knowledge in their research. The studies by Kitchin and Golledge suggested that “by the age of 18, given no age, education, and social differences, males and females have equal cognitive mapping knowledge and ability” (Kitchin, 1996, p. 285).

Overall, there is no clear evidence to suggest that there are superior levels of wayfinding skills by one gender. Women have been shown to be superior in tasks that deal with landmarks and estimate distances better (Lawton, 1996). Men, on the other hand, outperform women on knowledge acquired from travel experience (Kitchin & Freundschuh, 2001). Men also excel at survey-type tasks. These tasks include recognition of the overall environment, directional cues, and *out-of-sight* objects.

Silverman and Eals (1992) indicated that there are no significant differences between genders on cardinal location tasks. These tasks typically include recognition of numbers in graphics and signage. In contrast, Brown et al. (1998) suggested men are more accurate than women in identifying and using directional indicators and cardinal numbers as wayfinding cues. Additionally, Ward et al. (1986) indicated that males use more cardinality and mileage indicators than females and make fewer errors under memory conditions although both male and females rely on landmarks (p. 213)

Malinowski and Gillespie (1998) discovered that in their study of language and wayfinding, bilingual adults scored significantly lower than monolingual adults. Bilingual adults had slower wayfinding task completion times and found fewer reference points than did residents from monolingual homes. In addition, bilingual women scored significantly lower on wayfinding activities. Participants had slower task completion times and found fewer reference points than in monolingual homes. In addition, bilingual women scored significantly lower on wayfinding task activities. Gender differences in spatial skills may have implications for everyday wayfinding.

Research has shown that gender differences in perception of space may affect the strategies used by women and men in finding their way in unfamiliar environments, as well as the types of information they relay when giving directions to others (Lawton, 2001). Gender differences in cognitive abilities have most consistently been found in the area of spatial skills. As examples, five studies (Hunt, Pellegrino, Frick, Farr, & Alderto, 1988; Law, Pellegrino, & Hunt, 1993; Linn & Petersen, 1985, 1986; Schiff & Oldak, 1990) determined that “men tend to perform better than women on abstract laboratory tests involving mental rotation of three-dimensional objects, identification of true horizontality or verticality in a distracting context, or judgments about the speed or destination of moving targets” (Lawton, 2001, p. 321). Montello, Lovelace, Golledge, and Self (1999) also believed that women appear to excel at some wayfinding tasks and men on other tasks.

Montello et al. (1999) and Self, Gopal, Golledge, and Fenstermaker (1992) believed gender differences exist in wayfinding skills. These authors determined that men tend to be more accurate than women in judgments of directional relationships. Tasks better performed by men include indicating out-of-sight landmarks and locating hidden targets in real or simulated environments (Astur, Ortiz, & Sutherland, 1998; Holding & Holding, 1989; Lawton, 1996; Lawton, Charleston, & Zieles, 1996; Lawton & Morrin, 1999). Men also are more accurate than women in depicting directional relationships between landmarks in sketch-map drawings of previously viewed environments (McGuiness & Sparks, 1983; Montello et al., 1999) and when answering questions about directional relationships of locations previously seen on a map (Galea & Kimura, 1993). In contrast, women tend to be more accurate than men in remembering landmarks including their locations. Women appear to have the advantage when identifying objects in an array whose locations have been changed (Eals & Silverman, 1994; James & Kimura, 1997; McBurney et al., 1997; Silverman & Eals, 1992). Additionally, women may be better at identifying the placement of a map of objects previously seen in a room (Montello et al., 1999; Silverman & Eals, 1992). Galea and Kimura (1993) also suggested that women can recall landmarks and street names from a map more accurately than men.

Women's performance seems to be equal to that of men when landmark cues are available, but worse than men when numeric cues such as cardinal numbers (e.g., 1, 5, 15) are utilized (Sandstorm, Kaufman, & Huettel, 1998). In contrast, this research also suggests that women's wayfinding behavior tends to be more affected by the absence of landmark cues. It appears that a lack of easily remembered landmarks in women's wayfinding may result in disorientation.

Environmental factors appear to play a role in shaping gender differences in spatial-related performance. Research by Baenninger and Newcombe (1989) indicated that previous experience with spatial activities (e.g., walking through a corridor) may increase performance with new paper-and-pencil spatial tasks. Extra training on spatial-related tasks also seems to increase performance for both women and men.

Taylor and Tversky (1996) believed,

> Overall, the current findings suggest that women are more likely than men to use a landmark-based navigational strategy, and men are more likely than women to incorporate a survey or overview perspective into route directions, as indicated by their frequency of reference to cardinal directions. (p. 371)

In addition, gender use of cardinal direction may vary by region of the country. Research by Taylor and Tversky (1996) suggested that "both women and men were more likely to refer to the cardinal directions if they lived in the Midwest/West region of the United States than if they lived in the Northeast/South region" (p. 371). This finding was predicted on the basis that the cardinal directions would be more salient in the Midwest/West, where property boundaries and, hence, the layout of roads, follow north-south/east-west grids established by the U.S. Public Land Survey.

Age Differences in Wayfinding

An improvement in wayfinding efficiency may result in an improvement in the quality of life for the elderly. Daily spatial activities such as walking through the house, taking a stroll in the neighborhood, or just going to the grocery store, are important aspects of everyday life for an aging population. To date, studies related to the elderly and wayfinding have focused on changes in ability levels, including a decline of abilities over time.

An interesting study of spatial skills by older adults was completed by Kirasic and Allen (1985). These researchers examined age-related deficiencies in speed and efficiency of wayfinding as it pertained to the older adult. The primary focus of their study was to provide a comprehensive review of the status of wayfinding research related to the elderly. Kirasic and Allen concluded many wayfinding studies lacked "real life" spatial situations. They suggested more research on spatial learning abilities across the life span. Their findings indicated a need to investigate the elderly's wayfinding acquired skills and navigational patterns in the environment. Kirasic and Allen also questioned whether processing speed is really what causes wayfinding deficiencies. The speed of processing information could be a major factor in the human ability to recognize places and landmarks. Rayner and Pollatsek (1992) suggested that fixed or stationary objects are more quickly identified and localized than moving objects. Siegal, Kirasic, and Kail (1978) suggested that younger children know less about route events than older children. This implies that younger children have less acquired knowledge.

Research suggests that there may be a decrease in route learning with age. Barrash (1994) determined that older adults made four times more mistakes than the younger adults when performing wayfinding tasks. Wilkniss et al.'s (1997) study showed no significant differences between older adults and younger adults regarding landmark recognition. However, the older adults had more trouble memorizing and retracing the route.

In order to navigate effectively, comprehension of spatial relationships along a route is required. In a wayfinding study by Lipman (1991), a slide presentation was used to test memory of a route by older adults and college students. Significant differences in age were determined for memory of content and organization of a route. Older adults used landmarks rather than order sequence to assimilate spatial information. Lipman (1991) believed this tendency on the part of older adults to rely on the non-spatial characteristics of routes may underlie their poorer wayfinding performance observed in unfamiliar environments.

Kirasic (1999d) studied the effect of age differences on wayfinding with the use of maps, verbal descriptions, and slide presentations. There was a strong improvement by all wayfinding participants with the use of verbal cues and an even stronger improvement with the use of maps. Supplementing participants' information with spatial information improved all participants' navigation skills. Kirasic indicated that "age itself was not a factor in this training study" (Kitchin & Freundschuh, 2001, p. 171). One may infer that supplementing or providing multiple sources of spatial information to not only older but also younger adults would positively impact their spatial behavior.

These findings were consistent with previous research. Kirasic and Mathes (1990) indicated that “elderly subjects perform a variety of environmental tasks with considerable accuracy and efficiency after receiving a preview of the environment” (p. 605). This study’s findings could be especially applicable to older adults who tend to show poorer performance on a variety of spatial tasks. As a result of his studies, Kirasic (1999a) suggested future studies focusing on ways to identify older adults’ spatial abilities and the processes related to their spatial behavior.

Regional Differences in Wayfinding

Use of cardinal numbers and points for directions in wayfinding may vary by region of the country. Research by Taylor and Tversky (1996) suggested that women and men were more likely to refer to the cardinal directions if they lived in the Midwest/West region of the United States than if they lived in the Northeast/South region. This finding was predicted on the basis that the cardinal directions would be more salient in the Midwest/West, where property boundaries and, hence, the layout of roads follow north-south/east-west grids established by the U.S. Public Land Survey.

Moar and Carleton (1982) suggested that wayfinding knowledge may be determined by environmental cues. For example, if a city route plan is set up on a grid-layout then the wayfinder may assume that routes are straight and at right angles to one another. City planners often make use of cardinal numbers or points along their major routes and street grids.

Chase (1983) completed an extensive study of taxi drivers in Pittsburgh, Pennsylvania. This researcher suggested that wayfinding navigation is not determined by memory of landmarks or a “map in the head” of the taxi driver. Instead, wayfinding navigation may be based on the organization of the street system, locations of neighborhoods, and their global features such as rivers and hills. Hence, the geography and function of travel may determine the routes that are learned.

Property boundaries in the United States were often established because of historical circumstance. Campbell (2001) determined that regional property boundaries of the United States were established using land-partitioning systems that differ in their alignment with the cardinal directions. In earlier settled areas, such as the states east and south of the Ohio River, property boundaries were established in an unsystematic manner, usually due to a settler's or landowner's claims. Exceptions to this method of planning boundaries are seen in Florida, Alabama, Mississippi, and Louisiana. In these four states, surveys recorded the property boundary deviations from a North/South reference line. In contrast, planners in the West and Midwest states used a more systematic method known as the U. S. Public Land Survey (Campbell, 2001). This latter method divided land into rectangular subdivisions aligned along north-south and east-west references lines. Many roads run along property boundaries. Roads in these West and Midwest regions tend to be aligned with cardinal directions. Therefore, Lawton (2001) suggested that men and women living in the Midwest/West may be more likely to use cardinal directions in wayfinding. The region of the country may have an environmental effect on referencing cardinal directions for both genders. Lawton (2001) also suggested that regional differences are seen for gender with respect to right/left usage. This researcher suggested that men and women are less likely to use the terms right/left in areas where the cardinal points (e.g., North, South, East, and West) are shown geographically at intersections.

Lawton (2001) used an Internet survey to study spatial abilities in relation to gender and regional differences. This research included survey participants living only in the United States. Lawton determined that both men and women used cardinal numbers and points for wayfinding if they lived in the Midwest/West, in contrast to those persons who lived in the Northeast/South regions of the United States. In addition, both men and women relied on cardinal numbers for wayfinding if they lived in areas where the streets and roads were arranged in grid patterns. Although men and women differ in their use of spatial referents for direction giving and spatial navigation, direction giving and wayfinding patterns of both men and women are affected by the regional environment in which they live (Lawton, 2001).

Landmarks

An object must be part of a spatial relationship to be considered a landmark. Landmarks are defined in relation to another object or frame of reference (Blades, 1989; Presson & Montello, 1988). Landmarks may serve as a point of reference during wayfinding because one's senses register spatial configurations during wayfinding. In the absence of landmarks, most routes are remembered by the familiarity of places as they are encountered (Kirasic, 1999c). Cornell et al. (1994) suggested that the strongest memories occur when the path is viewed in the original direction of travel.

A benchmark study of environmental cognition by Lynch (1960) also emphasized the importance of landmarks in wayfinding. His research findings are an important milestone in environmental cognition theory by wayfinding researchers. Lynch determined that people tend to organize spatial environments in terms of five elements: (a) memorable landmarks; (b) paths people follow; (c) nodes where paths cross; (d) edges of neighborhoods (i.e., generally accepted navigation paths); and (e) socially or physically defined districts in wayfinding. Lynch believed that these well-defined paths and distinctive landmarks help make the environment legible in wayfinding.

Landmark Use

Allen, Kirasic, Siegel and Herman (1979) indicate that (a) adults and children may not spontaneously select the same features as real-world landmarks; (b) children are less capable than adults in judging the value of potential landmarks as distance cues; and (c) the ability to environmental landmarks as cues for distance information developmentally precedes the ability to assess this potential information value (p. 1068).

Valiquette, McNamara and Labrecque (2007) indicate a strong bias to represent the spatial structure of navigable environments with reference directions or axes that are aligned with salient environmental frames of reference (p. 296). Landmarks and design features represent these frames of reference. Attention needs to be directed toward these reference points when designing interior space.

Mou, Zhao, and McNamara (2007) in conjunction with previous findings, suggest that when people learn locations of objects on a new environment, they use their experiences in the environment, spatial and nonspatial properties of the objects, and cues in the environment to select a frame of reference intrinsic to the layout itself. This frame of reference determines the interpretation, and hence, the memory of the spatial structure of the layout (p. 170). These findings are consistent with previous research which suggests that people use past experiences (Carpman & Grant, 1983, Proulx, 2002).

Route Layout and Wayfinding

The use of routes for wayfinding is common to everyday life. Wayfinding is a natural process that is used throughout our lifetime. One cannot separate route learning from wayfinding. The two are linked. Typically, the traveler begins with an anchor point and proceeds methodically based on geographical information. Successful route performance may depend on the use of this wayfinding information. Behavioral geographers have suggested that knowledge of route can be conceptualized as a series of procedural descriptions of the environment (Golledge & Stimson, 1997).

Maps in Wayfinding

In their study of case histories of persons lost in wilderness areas, Heth and Cornell (1998) determined that route maps in guide books, you-are-here postings, or pamphlets available at visitor centers were sometimes insufficient for wayfinding assistance. Often the maps were incorrectly located or were out-dated. Passini's (1981, 1984) wayfinding model stressed the importance of processing environmental information during wayfinding. He described the environment from this informational point of view for wayfinding. Similarly, research by behavioral scientists Garling, Book, and Lindberg (1986) has shown the following three physical setting variables are related to maps in wayfinding: degree of differentiation, degree of visual access, and complexity of spatial layout. Each variable reflects the requirements for basic cognitive processes such as recognition of parts, localization of reference points, recall, and selection and sequencing of destinations.

Additionally, Weisman (1981) cited four important physical measures that affect wayfinding: (a) visual access to cues and landmarks, (b) architectural differentiation, (c) signs, and (d) plan configuration. Additional research by Haq (1999) suggested that as people become familiar with an environment, they may gain more knowledge of the overall configuration of the layout. This finding suggests that learning overall configuration with the use of maps may help visitors better understand wayfinding problems in complex buildings. Findings by Braaksma and Cook (1980), Peponis, Zimring, and Choi (1990), and Zimring and Willham (1998) support Haq.

These studies show that people do not give equal value to maps when wayfinding. People may not understand wayfinding maps, not use them, or not notice them.

Color as a Landmark

The body of knowledge on color is extensive. Although there are conflicting views on color and human response, many researchers agree upon color impact on human behavior (Birren, 1978; Gordon & Nuckolls 1995). Aging adults and the visually impaired, as well as the general public, may utilize color contrast and light to navigate in the environment. Gordon and Nuckolls (1995) suggested that artificial lighting should be arranged to provide uniform illumination, with task lighting used as necessary for working. Daylight should be planned to ensure the even distribution of light, although pools of light can give directional clues. Additionally, color contrast is important in wayfinding design to help demarcate perimeters, highlight obstructions, and identify locations (Royal National Institute for the Blind, 1995). Williams' (2001) "Aging in Place" study for American Society for Interior Design suggested additional research is needed on the effect of color on the aging population. Williams stated, "Color perception alters with aging. The mature eye perceives color like it is looking through an amber-colored filter" (p. 17). The American Society for Interior Design research findings suggested that color contrast in wayfinding routes is especially beneficial to the elderly and visually impaired.

Landmarks, Design Features and Life Safety

An object must be part of a spatial relationship to be considered a landmark. Landmarks are defined in relation to another object or frame of reference (Blades, 1989; Presson & Montello, 1988). Landmarks serve as a frame of reference because one's senses register spatial configuration. Landmarks are spatial anchors because they provide precise information about location. Landmarks may include primary and secondary references, signage, building configuration, floor plan complexity, lighting, and color-coding. A primary landmark is always present (such as stairs or an escalator). A secondary landmark is not always present or encountered.

Design features in the built environment perform different functions. Design features may include architectural treatments, building configuration, furniture, fixtures and equipment, finishes, lighting, color, and signage. Some of the most important design features are life safety features. Life safety design features may include building configuration, exits, exit marking, directional signage and lighting. Architects, engineers, code officials, contractors, interior designers, as well as other design professionals seek to integrate knowledge of human behavior, interaction, movement and memory when designing interior space. One aspect of this knowledge understands the complexity of behavior and the human mind and how it will affect design construction.

Separation of exits is required in the design of a building so that if one exit is blocked, occupants may still have another route or means of leaving the building. Occupants rely on visual cues such as design and architectural features to aid in developing navigation strategies. These visual cues provide mental images for occupants in the built environment.

To the degree that a setting provides perceptual access to the entire setting, it facilitates the formation of better mental images. Limiting visual access to building parts jeopardizes the formation of complete mental maps. The separation of means of egress also can affect exit recognition. When there is a lack of visual access, people must rely more on other cues, such a signage (Ozel, 1993; Ozel, 2004, p. 133).

Occupant memory oftentimes relies on reinforcement. This reinforcement provides effects tools for creating mental images and strategies. Reinforcement of important design features is another method design professionals may utilize in life safety procedures. An important design feature is exit marking. The *Life Safety Code 101* provides specific directives and strictly monitors the exit marking in the built environment. Exit marking refers primarily to the placement and design of exit signage. Redefining it as an environmental cognitive factor can bring a broader definition to the concept (Ozel, 1993; Ozel, 2004, p. 133).

Understanding cognitive factors such as memory of design features; more specifically, exit signage is critical. The remembrance of life safety features may mean the difference between getting out of the building in times of duress. Typically, exit signage is used to produce physical distinctiveness at a location, such as an exit door, that otherwise might not be recognized during a fire. Design method—standardizing exit elements, color coding, and greater visual access to exits and stairs—may facilitate exit recognition. As new design concepts are incorporated into exit marking, we should be aware that any physical feature that enhances the physical distinctiveness of a setting and increases visual access will facilitate better use of such settings. Exit recognition is a factor of associations with multiple environmental cues (Ozel, 1993; Ozel, 2004, p. 133).

The types of associations with environmental cues are critical. People tend to focus on the negative aspects of an event when pressed for time during decision-making. (Ozel, 2007) Since emergency exiting is a decision process that occurs under time pressure, we must consider how people use environmental cues.

Unless otherwise indicated, the National Fire Protection Association (NFPA, p. 101) assumes equal use of alternative exits. But route selection must be the determining factor in calculating the capacity of exits, particularly in buildings where more than two protected exits meet egress capacity requirements. Occupants are more likely to use exits that are at physically distinctive locations, provide more visual access, and are located at specific locations with respect to the overall geometry of the building.

The cognitive expectancies of occupants also are important in determining the capacity of exits. Sime and Kimura (1988) compared route selection and exit use during a monitored evacuation study. Findings indicated that direct visual access and regular use contributed to the formation of a biased cognitive map for exit use.

Physical and cognitive accessibility as well as plan configuration are important to the design of remote exits. Clear physical and functional distinctiveness make a building interior more cognitively accessible. Lack of physical and distinctive landmarks or feature in an interior may contribute to difficulties in orientation, locating destinations, and returning to starting points because of disorientation (Ozel, 1993; Ozel, 2007, p. 135).

The term “exit time” should be replaced with “exit access time.” Factors that affect exit access time, more specifically, memory factors, should be specified as part of the performance criteria. While exit time implies immediate access to and use of exits, exit access time makes a distinction between having physical and cognitive access to an exit and its actual use. It is this cognitive element that may need further examination in the built environment.

Exit elements must also be rated cognitively. Such specifications require the grouping of building configurations, such as linear, concentric, U-shaped, atrium or courtyard, and composite building; rating the degree of visual access to other sections of a building and/or to its exterior; and rating the physical distinctiveness of building parts. An extensive guide covering these principles should be provided in the *Life Safety Code Handbook*. Finally, full-scale tests are needed to address the combined egress performance of exit elements, similar to tests of other building components to obtain fire ratings for those assemblies. Moreover, such tools as emergency egress simulation can assist code enforcement officials in assessing the emergency egress performance of buildings (Ozel, 1993, 2007).

Summary

In summary, the literature review has addressed six areas: memory, wayfinding, memory and wayfinding, age, gender, and landmark effects in the built environment. The literature on memory associated with gender and ethnicity suggests more research is needed to identify memory features of design features in the built environment. The importance of navigation, movement and wayfinding in the built environment is addressed. However, questions remain with respect to attention span and information processing of design features in wayfinding. The research is inconclusive on the effect these visual elements may have on gender and ethnicity when wayfinding. More research may be needed to supplement possible gaps in the literature regarding memory of visual design elements, its interaction with wayfinding navigation and its impact on building design.

Research suggested that wayfinding cues may aid both young and old alike in navigation of the built environment. Men make use of maps and directional cues, while women and older adults use landmarks. Women tend to have better memory of the navigation route and judge distances better than men. However, men may perceive “out-of-sight” objects and cardinal cues more readily than women in wayfinding routes. The literature also suggests that repeated experiences using the same wayfinding route are an aid. Supplementing spatial information with wayfinding cues and landmarks may also improve wayfinding performance. These “practice” sessions may be helpful in improving navigation skills.

CHAPTER III. METHOD OF STUDY AND INSTRUMENTATION

Chapter I provided background information and a theoretical framework for this study, statement of the research problem, purpose of the study, research questions, hypotheses, definition of terms, assumptions, limitations, and the significance of the study. Chapter II presented a review of research and literature related to memory of the built environment, prerequisites for wayfinding, memory and interaction of memory systems, object location memory, visual connections, processing speed, memory tasks, the connection of memory and wayfinding, gender differences, age differences, landmarks, environmental complexity, decision making, anxiety, route layout and maps, and the implications of cognition to building codes and life safety. The review of literature contained research-based information on the fundamental aspects of incorporating cognitive expectancies in space planning and design in the built environment. A discussion of landmarks, building configuration and complexity, lighting, color and signage were discussed. Chapter III discusses the methodology used in this study. The sources of data and the data collection procedures, privacy and confidentiality of student data collected, instrumentation, and procedures for data analysis are presented.

Outline of the Study

This chapter is divided into five sections. The first section described the design of the study and purpose of the study. The second section described the sources of data and data collection procedures. The third section described the privacy and confidentiality of the participants. The fourth section described the survey instrument used in the study. The fifth section described the procedures for data analysis.

Sources of Data and Collection Procedures

The data were obtained from students enrolled in Virginia College in Birmingham, Alabama. Students enrolled in Applied Health, Business Administration, Computer Aided Drafting and Design, Computer Animation and Game Design, Design Visualization, Interior Design, Legal Studies, Nursing and Web Design and Development were recruited for the study.

The researcher obtained permission from the President of Virginia College in Birmingham, Alabama, and the Academic Dean of Virginia College in Birmingham, Alabama to conduct this study. A copy of the letter requesting permission to conduct this study is included in Appendix A.

Privacy and Confidentiality of Student Data Collected

Appropriate steps were taken to insure the privacy and confidentiality of the data. The researcher obtained permission from the Institutional Research Board (IRB) of Auburn University to conduct this study. As required by the IRB, the researcher also obtained permission from Virginia College to conduct this study with the understanding that only the researcher had permission to view student records. A copy of the Auburn University IRB approval letter is included in Appendix A. The researcher did not share any personal or private information with others. During the study, all data obtained using the recording forms were kept in secure files at the researcher’s residence. A numbering system was used to keep student information anonymous.

Instrumentation

A researcher-developed instrument was used to collect the data. The survey instrument allowed the researcher to record the following information for each participant in the study: gender, age, ethnicity, college major, years of professional experience and hometown. A copy of the survey instrument is included in Appendix B.

Research Instrument

Part I: Slide Presentation

The instrument for this research consisted of two parts: a slide presentation and a survey instrument. Part I, the slide presentation, consisted of views of entry and interior corridors at the Druid City Hospital Medical Office Tower in Tuscaloosa, Alabama. The Medical Office Tower has distinguishing architectural and interior design landmarks, which research has shown to be helpful in wayfinding. The slide presentation was designed by the researcher and her major professor. A panel of experts validated the slide presentation. The slide presentation was designed to be approximately five minutes in length. A slide presentation format was utilized in this study because it helped to eliminate environmental changes in the navigation route that could affect the results of the study. Thus, the slide presentation provided the same graphic presentation to all subjects. A slide presentation also brought the navigation route to the research participants rather than having the participants physically travel through a wayfinding route.

Carpman and Grant (1993) established the validity and reliability for using a slide presentation as an instrument in wayfinding research. They conducted multiple assessments with the same instrument to establish reliability. The Kuder Richardson 20 reliability coefficient was .88 (Carpman & Grant, 1993). The slide presentation used by Carpman and Grant (1993) proved to be reliable and valid in the wayfinding research of hospital navigation. In a wayfinding study by Lipman (1991), a slide presentation was used to test memory of a route by older adults and college students. The PowerPoint slide presentation used in this study utilized distinguishing landmarks or points of reference in Druid City Hospital Medical Office Tower to develop the navigation route. Two floors of the Druid City Hospital Medical Office Tower were photographed showing a “walk through” of the corridor and its landmarks such as doors, signage, flooring graphics, and other distinguishing points of wayfinding reference.

The PowerPoint slide presentation entitled “Memory of Design Features in the Built Environment” included 52 slides in sequential order of the Druid City Hospital Medical Office Tower’s interior navigation route. The PowerPoint slide presentation was used to bring the navigation route to the participants in order to control for environmental variables.

The exterior of the building was shown as well as distinguishing points of reference in the building’s interior corridors. Special attention was placed on entrance points, stairs, elevators, and notable interior landmarks. The final sequence of slides showed an exit path through the lobby of the building.

Part II: Survey Instrument

The survey instrument included 63 items. It was organized into three sections (see Appendix B). The first section of questions concerned wayfinding memory of design features in the built environment. The second section of questions examined wayfinding preferences. The last section of questions requested demographic data of individuals enrolled in the programs.

Part II: Section I of the survey instrument. Section I of the survey instrument included questions of design features in the built environment shown in the slide presentation. Memory refers to the recall of interior architectural and design features that may be useful in the built environment. General memory and specific memory questions for design features were included in questions 1–43 for a total memory score. General memory refers to the overall recall of interior architectural and design features that may be useful in the built environment. Specific memory refers to the detailed recall of interior architectural and design features that may be useful in the built environment.

Items for Section I of the research instrument were determined, in part, by the researcher walking through buildings to determine wayfinding landmarks. Notes were taken of distinguishing architectural landmarks for buildings. The researcher compared findings of previous studies that identified significant landmarks to include in the survey instrument. A panel of four design professionals reviewed the landmarks and design features to establish content validity of Part II of the instrument. A copy of the survey instrument is shown in Appendix B. Also, selected questions from the research instruments by Passini (1998), Lawton (1996, 2001), Schmitz (1999), Haq (1999), and Carpman and Grant (1993) were utilized in the final survey instrument. Content validity for Section I of the research instrument was established by comparing items on the researcher-developed instrument to those developed from existing research. Carpman and Grant (1993), Schmitz (1999) and Lawton (2001) designed a similar instrument that was modeled for this study. Reliability of Part III of the instrument for this study was established using the Kuder Richardson 20. The Kuder Richardson 20 reliability coefficient was .77 for Section I. Content validity for Section I of the research instrument utilized a committee of experts that included four design professionals and a researcher.

Forty-three questions were included on memory of architectural and interior design features. Examples of memory items included “elevators, fire extinguishers, evacuation maps, bathrooms, stairs, signage, room numbers, flooring and furniture.”

The scoring was based on the respondents accurate recollection of landmarks included in the PowerPoint slide presentation. The participants were requested to select the design features that they recalled from the PowerPoint slide presentation. Written instructions for responding were included. Participants responded yes if they recalled the item and no if they did not recall the item. A score of 1 was given for correct answers and 0 for incorrect answers on the yes/no items of the research instrument. The number of correct answers was summed to produce a total memory score. The total memory score represented the recall of each participant for the design features shown in the slide presentation.

Part II: Section II of the survey instrument. Section II of the survey instrument addressed participants' "wayfinding preferences" in relation to 11 selected architectural and interior design features shown in the slide presentation. Examples of wayfinding preference items included "identify location maps", "notice balance or configuration", look for landmarks", usefulness of directional signs", pay attention to numbering on doors and signs", "use floor pattern", "use color", and "like hearing background sound".

Each participant was instructed to circle preferred answers using a 5-point Likert-type rating scale to identify their "wayfinding preferences." Response options ranged from *always* (5) to *never* (1). "Wayfinding preferences" are defined as the architectural and interior features that are used regularly as wayfinding aids. Participants were instructed to circle their answer for each of the 11 items (see Appendix B). A score of 5 meant participants always preferred that specific design feature as a wayfinding aid and a score of 1 meant that participants never preferred that specific design feature as a wayfinding aid. Reliability was established for Part II: Section II of the instrument using the Kuder Richardson 20. The Kuder Richardson 20 reliability coefficient was .71 for Part II Section II. Also, content validity for Part II: Section II of the research instrument was established by a committee of experts that included four design professionals and a researcher.

Part II: Section III of the survey instrument. Section III of the survey instrument requested demographic information. The demographic items provided information on gender, ethnicity, age, marital status, hometown, education level, and college major.

Method of Procedure

Descriptive data such as frequency distributions, mean scores, maximum and minimum scores were calculated. The null hypothesis was tested using the two-way analysis of variance procedure. The alpha level was set at .05 to indicate whether significant differences existed between groups.

Procedure for Data Analysis

The Statistical Packet for the Social Sciences (SPSS), release 16.0, was used to address the research questions in the study.

The first research question asked: What are the demographic characteristics of individuals enrolled in these programs? Descriptive statistics were calculated to respond to this question (Ary, Jacobs, & Rasavich, 2005).

The second research question asked: What is the frequency and percent of responses for all participants on memory of design features? Descriptive statistics were calculated to respond to this question (Ary, Jacobs, & Rasavich, 2005).

The third research question asked: To what extent are there differences on memory of design features in the built environment based on gender and ethnicity? A null hypothesis was tested using the two-way analysis of variance procedure to respond to this research question.

The fourth research question asked: What are the wayfinding preferences based on gender and ethnicity? Descriptive statistics were calculated to respond to this question (Ary, Jacobs, & Rasavich, 2005).

Participants

Survey instruments from 129 students were collected. Sixty-four (50.4%) were male and 63 (49.6%) were female. Of the 150 students that were asked to participant in the study, 129 responded for a response rate of 86%.

Summary

This chapter discussed the methodology used in this study. The sources of data and the data collection procedures, privacy and confidentiality of student data collected, instrumentation and procedures for data analysis were discussed. The data analysis and results are presented in Chapter IV.

CHAPTER IV. DATA ANALYSIS AND RESULTS

Chapter I provided background information and a theoretical framework for this study, statement of the research problem, purpose of the study, research questions, hypotheses, definition of terms, assumptions, limitations, and the significance of the study. Chapter II presented a review of research and literature related to memory of the built environment, prerequisites for wayfinding, memory and interaction of memory systems, object location memory, visual connections, processing speed, memory tasks, the connection of memory and wayfinding, gender differences, age differences, landmarks, environmental complexity, decision making, anxiety, route layout and maps, and the implications of cognition to building codes and life safety. The review of literature contained research-based information on the fundamental aspects of incorporating cognitive expectancies in space planning and design in the built environment. A discussion of landmarks, building configuration and complexity, lighting, color and signage were discussed. Chapter III presented the methods and procedures used to identify and select subjects to be studied, general procedures for the data collection and recording, design of the study, and statistical treatment of the data. Chapter IV addresses the results of the data analysis. Research findings addressing the three research questions and corresponding hypotheses are discussed in this chapter.

Data Analysis

Descriptive data such as frequencies, mean scores, minimum and maximum scores were summarized from the data collected. The descriptive data were used to answer research questions one, two, and four. Research question three was tested with a null hypothesis using the two-way analysis of variance. The two-way analysis of variance was conducted to compare memory of the 43 design features for gender and ethnicity. The alpha value was set at .05.

Results for Research Question One

The first research question was:

1. What are the demographic characteristics of individuals enrolled in Applied Health, Business Administration, Computer Aided Drafting and Design, Computer Animation and Game Design, Design Visualization, Interior Design, Legal Studies, Nursing, and Web Design and Development?

Demographic Characteristics

Demographic characteristics for all participants enrolled in programs for this study were summarized in terms of age, gender, ethnicity, college major, years of professional experience and hometown. Participants were asked to respond to demographic questions including age, gender, ethnicity, years of professional experience and hometown.

Participants were almost equally divided by gender: 65 (50.4 %) were male and 64 (49.6%) were female. Of the 129 participants, 95 (73.6%) were 16–30 years of age, 17 (13.2%) were 31–40 years of age, 15 (11.6%) were 41–50 years of age, and 2 (1.6%) were 51–60 of age. Participants were primarily single. Of the 129 participants, 95 (73.6%) were single, 24 (18.6%) were married, 8 (6.2%) were divorced and 2 (1.6%) were widowed. The majority of participants were Caucasian. Of the 129 participants, 63 (48.8%) were Caucasian, 52 (40.3%) were Black/African American, 5 (3.9%) were Hispanic, and 9 (7.0%) were Other ethnicity. Of the 129 participants, 57 (44.2%) were Computer Aided Drafting and Design, 71 (55%) were Computer Animation and Game Design, and 3 (2.3%) were Computer Programming and Information

Systems. Additionally, 94 (72.9%) of participants had other degrees including business management, nursing, and legal studies.

Most of the respondents (118 or 91.4%) were from the Southeastern region of the United States. Demographic characteristics of the sample are shown in Table 1.

Table 1

Demographic Characteristics of Survey Participants

Characteristics	*n*	%
Age		
16-30	95	73.6
31-40	17	13.2
41-50	15	11.6
51-60	2	1.6
Gender		
Male	65	50.4
Female	64	49.6
Marital status		
Single	95	73.6
Married	24	18.6
Divorced	8	6.2
Widowed	2	1.6

(table continued)

Table 1 (continued)

Characteristics	*n*	%
Level of education		
Some high school	6	4.7
Completed high school	5	3.9
Some college	110	85.3
Completed college	8	6.2
College major		
Interior design	57	44.2
Computer Aided Drafting & Design/Game Design	71	55.0
Computer Programming and Information Systems	3	2.3
Applied Health/Medical/Legal Studies/Law	3	2.3
Business Management	2	1.6
Other	18	14.0
Hometown Region		
Southeast	118	91.4
West	3	2
Northeast	2	1
Southwest	0	0
Midwest	6	4.6

Results for Research Question Two

The second research question was:

1. What are the frequency and percent of responses for all participants on memory of design features?

Frequency and Percent of Responses

Overall, architectural design features were most often recalled by participants than any other design feature. Examples of architectural design features most often recalled were elevators (96.9%), windows (95.3%), stairs (90.7%) and columns (89.1%).

Memory of life safety design features most often recalled were windows (95.3%), stairs (90.7%) and emergency lighting (51.2%). Frequency and percent of other life safety features were fire extinguishers (20.9%), fire alarms (34.9%), evacuation maps (29.5%), and you-are-here maps (24.8%).

In terms of directional indicators, overhead signs (93.0%) were most often recalled rather than room numbers (35.7%). Other than chairs (93.8%), desks (89.9%), trash bins (72.9%) and sofas (79.1%), furniture, fixtures and equipment were not recalled as frequently as static objects such as permanent architectural design features. Frequency and percent of responses for the sample are seen in Table 2.

Table 2

Frequency and Percent of Respondents on Memory of Design Features

	Recall		Did Not Recall	
Design Features	n	%	n	%
1 Stone flooring	96	74.4	33	25.6
2 Elevator	125	96.9	4	3.1
3 Benches	70	54.3	59	45.7
4 Chairs	121	93.8	8	6.2
5 Plants/shrubbery	118	91.5	11	8.5
6 Tables	59	45.7	70	54.3
7 Fire extinguishers	27	20.9	102	79.1
8 Fire alarms	45	34.9	84	65.1
9 Emergency lighting	66	51.2	63	48.8
10 Evacuation maps	38	29.5	91	70.5
11 Bulletins/displays	58	45.0	71	55.0
12 Framed art/awards	105	81.4	24	18.6
13 Clocks	92	71.3	37	28.7
14 Portraits	93	72.1	36	27.9
15 Landscape paintings	103	79.8	26	20.2
16 Drink/snack machines	28	21.7	101	78.3
17 Bathroom	32	24.8	97	75.2
18 Room numbers	46	35.7	83	64.3
19 Overhead signs	120	93.0	9	7.0

Table 2 (continued)

Design Features	Recall n	Recall %	Did Not Recall n	Did Not Recall %
20 You-are-here maps	32	24.8	97	75.2
21 Windows	123	95.3	6	4.7
22 Water fountain	34	26.4	95	73.6
23 Stairs	117	90.7	12	9.3
24 Trash bins	94	72.9	35	27.1
25 Food	42	32.6	87	67.4
26 Drug store	111	86.0	18	14.0
27 Sofas/couches	102	79.1	27	20.9
28 Animals	8	6.2	121	93.8
29 Piano	38	29.5	91	70.5
30 Columns	115	89.1	14	10.9
31 Desks	116	89.9	13	10.1
32 Televisions	44	34.1	85	65.9
33 Newspaper stands	46	35.7	83	64.3
34 Wheelchairs	105	81.4	24	18.6
35 Flag	75	58.1	54	41.9
36 Flower arrangements	69	53.5	60	46.5
37 Sinks	8	6.2	121	93.8
38 Magazine racks	53	41.1	76	58.9
39 Escalator	43	33.3	86	66.7

Table 2 (continued)

Design Features	Recall		Did Not Recall	
	n	%	n	%
40 Revolving door	51	39.5	78	60.5
41 Patient comments	20	15.5	107	82.9
42 Animal portraits	2	1.6	127	98.4
43 Aquarium	3	2.3	126	97.7

Results for Research Question Three

The third research question was:

2. To what extent are there differences on memory of design features in the built environment based on gender and ethnicity?

This question was answered by testing the following null hypothesis: H_{O1}: There is no statistically significant difference in mean scores for memory of design features based on gender and ethnicity.

A two-way analysis of variance statistical procedure was used to test the null hypothesis. The independent variables were gender and ethnicity. The dependent variable was memory of design features. Results of the two-way analysis of variance indicated no statistically significant differences for gender, $F(1,122) = .000$, $P = .99$, partial eta squared was 0. Statistically significant differences were shown for ethnicity, $F(3,122) = 11.20$, $P = .00$, partial eta squared was .22. No statistically significant interaction effects for gender by ethnicity were indicated. $F(2,122) = .340$, $P = .71$, partial eta squared was .006. Table 3 displays mean scores and standard deviations by gender and ethnicity.

Table 3

Means and Standard Deviations for Memory Scores of Design Features

Gender	Ethnicity	Mean	Standard Deviation	N
Male	White/Caucasian	65.06	4.534	33
	Black/African-American	61.25	6.672	20
	Hispanic	65.00	.000	5
	Other (please specify)	74.00	.000	7
	Total	64.85	6.060	65
Female	White/Caucasian	65.47	8.605	30
	Black/African-American	59.75	6.691	32
	Other/please specify	75.00	.000	2
	Total	62.91	8.303	64
Total	White/Caucasian	65.25	6.730	63
	Black/African-American	60.33	6.659	52
	Hispanic	65.00	.000	5
	Other (please specify)	74.22	.441	9
	Total	63.88	7.297	129

The mean score for White/Caucasian was 65.25 with a standard deviation of 6.73; the mean score for Black/African American was 60.33 with a standard deviation of 6.66. Table 4 displays tests of between-subjects effects for memory of design features.

Table 4

Tests of Between-Subjects Effects for Memory of Design Features

Source	Type II Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1776.160	6	296.027	7.167	.000	.261
Intercept	182016.111	1	182016.111	4406.736	.000	.973
Gender	.011	1	.011	.000	.987	.000
Ethnicity	1387.940	3	462.647	11.201	.000	.216
Gender* Ethnicity	28.094	2	14.047	.340	.712	.006
Error	5039.095	122	41.304			
Total	533281.000	129				
Corrected Total	68.15.256	128				

Bonferroni post hoc tests showed a statistically significant mean difference (-8.97) between White/Caucasian and Other at the .05 level. The mean score for White/Caucasian was 65.25 with a standard deviation of 6.73, and the mean score for Other was 74.22, with a standard deviation of .441. Bonferroni post hoc tests showed a statistically significant mean difference (4.93) between White/Caucasian and Black at the .05 level. The mean score for White/Caucasian was 65.25 with a standard deviation of 6.73, and the mean score for Black was 60.33, with a standard deviation of 6.659. Bonferroni post hoc tests showed a statistically significant mean difference (-13.90) between black/African-American and Other at the .05 level. The mean score for black/African-American was 60.33, with a standard deviation of 6.659, and the mean score for Other was 74.22, with a standard deviation of .441.

Results for Research Question Four

The fourth research question was:

4. What are the wayfinding preferences based on gender and ethnicity?

Descriptive statistics were calculated to identify wayfinding preferences. Table 5 displays descriptive information for wayfinding preferences. There were 11 wayfinding preferences listed for responses. Respondents were to mark always, frequently, sometimes, seldom, or never for each item. The mean score for all males was 32.39, with a standard deviation of 7.537; the mean score for all females was 24.60 with a standard deviation of 5.008.

Table 5

Descriptive Statistics for Wayfinding Preferences by Gender and Ethnicity

Gender	Ethnicity	Mean	Standard Deviation	N
Male	White/Caucasian	32.39	7.537	33
	Black/African-American	30.55	4.673	20
	Hispanic	33.00	.000	5
	Other/please specify	37.00	.000	7
	Total	32.37	6.189	65
Female	White/Caucasian	24.60	5.008	30
	Black/African-American	27.63	3.925	32
	Other/please specify	37.00	.000	2
	Total	32.37	6.189	64

(table continues)

Table 5 (continued)

Gender	Ethnicity	Mean	Standard Deviation	N
Total	White/Caucasian	28.68	7.513	63
	Black/African-American	28.75	4.423	52
	Hispanic	33.00	.000	5
	Other/please specify	35.00	3.969	9
	Total	29.32	6.265	129

Mean scores and standard deviations were calculated for each wayfinding item by gender. For wayfinding preference, identify location maps, the mean score for males was 3.68 with a standard deviation of 1.187; the mean score for females was 3.17 with a standard deviation of 1.047. For wayfinding preference, usefulness of you-are-here maps, the mean score for males was 3.26 with a standard deviation of 1.228; the mean score for females was 2.28 with a standard deviation of .934. For wayfinding preference notice balance or building configuration, the mean score for males was 2.85 with a standard deviation of .601; the mean score for females was 2.03 with a standard deviation of 1.140. For wayfinding preference look for landmarks, the mean score for males was 1.95 with a standard deviation of 1.007; the mean score for females was 1.09 with a standard deviation of .294. For wayfinding preference, confident giving directions, the mean score for males was 2.82 with a standard deviation of .808; the mean score for females was 2.28 with a standard deviation of 1.00. For wayfinding preference, usefulness of directional signs, the mean score for males was 2.38 with a standard deviation of .860; the mean score for females was 1.97 with a standard deviation of .975. For wayfinding preference, pay attention to numbering on doors and signs, the mean score for males was 2.58 with a standard deviation of 1.467; the mean score for females was 2.11 with a standard deviation of .857. For wayfinding preference, think about orientation in building, the mean score for males was 2.72 with a standard deviation of 1.244; the mean score for females was 2.81 with a standard deviation of 1.641. For wayfinding preference, use floor patterns, the mean score for males was 3.86 with a standard deviation of .864; the mean score for females was 2.91 with a standard deviation of .971. For wayfinding preference, use color, the mean score for males was 2.98 with a standard deviation of 1.192; the mean score for females was 2.58 with a standard deviation of .956. For wayfinding preference, like hearing background noise, the mean score for males was 3.28 with a standard deviation of 1.206; the mean score for females was 2.98 with a standard deviation of 1.442. Table 6 displays wayfinding preferences for design features by gender.

Table 6

Mean and Standard Deviation for Wayfinding Preferences for Design Features by Gender

Item Number on Instrument	Mean	Standard Deviation
44. Identify Location Map		
Male	3.68	1.187
Female	3.17	1.047
45. Usefulness of You-Are-Here Maps		
Male	3.26	1.228
Female	2.28	.934
46. Notice balance or building configuration		
Male	2.85	.775
Female	2.03	1.140

(table continues)

Table 6 (continued)

Item Number on Instrument	Mean	Standard Deviation
47. Look for landmarks		
Male	1.95	1.007
Female	1.09	.294
48. Confident giving directions		
Male	2.82	.808
Female	2.28	1.000
49. Usefulness of directional signs		
Male	2.38	.860
Female	1.97	.975
50. Pay attention to numbering on doors and signs		
Male	2.58	1.467
Female	2.11	.857
51. Think about orientation in building		
Male	2.72	1.244
Female	2.81	1.641
52. Use floor patterns		
Male	3.86	.864
Female	2.91	.971
53. Use color		
Male	2.98	1.192
Female	2.58	.956
54. Like hearing background sound		
Male	3.28	1.206
Female	2.98	1.442

Summary

This chapter discussed the results of the data analysis. Descriptive data summarized the demographic characteristics of the students used in the study. The chapter provided information on memory scores of design features in the built environment based on gender and ethnicity. In addition, wayfinding preferences were identified based on gender and ethnicity. There was a statistically significant difference between the predictor variable of gender on memory of design features in the built environment. A summary of this study, conclusions, and recommendations are presented in Chapter V.

CHAPTER V. SUMMARY AND CONCLUSIONS

Chapter I provided background information and a theoretical framework for this study, statement of the research problem, purpose of the study, research questions, hypotheses, definition of terms, assumptions, limitations, and the significance of the study. Chapter II presented a review of research and literature related to memory of the built environment, prerequisites for wayfinding, memory and interaction of memory systems, object location memory, visual connections, processing speed, memory tasks, the connection of memory and wayfinding, gender differences, age differences, landmarks, environmental complexity, decision making, anxiety, route layout and maps, and the implications of cognition to building codes and life safety. The review of literature contained research-based information on the fundamental aspects of incorporating cognitive expectancies in space planning and design in the built environment. A discussion of landmarks, building configuration and complexity, lighting color and signage were discussed. Chapter III presented the purpose of the study, the general procedure of the data collection and recording, the methods and procedures used to identify and select subjects to be studied, and statistical treatment of the data. Chapter IV presented the results of the data analysis. This chapter will present a summary of the findings of the study, implications for further research, and recommendations for practical applications.

Overview of the Study

Problems related to the interior design of buildings typically include poor wayfinding systems. These wayfaring problems may be based on difficult-to-remember visual and spatial landmarks. There may also be gender and ethnicity influences on wayfinding effectiveness. Memory levels of visual cues used for wayfinding are thought to be important in everyday tasks. Related research shows inconsistent findings regarding gender and ethnicity memory in wayfinding.

According to Wright et al. (1996), gender and ethnicity related factors may play a role in wayfinding navigation. For example, the desire for better wayfinding systems may be affected by the gender and ethnicity related factors of lifestyle changes, physical abilities, increased life expectancies, and better healthcare. In addition, an increase in diverse market populations may encourage developers to increase budgets for wayfinding systems.

Gender and ethnicity related differences and preferences may also play a role in design of wayfinding systems. The literature suggested that men make use of maps and directional cues, while women and older adults use landmarks. In addition, the literature indicates women tend to have better memory of a navigation route. Women tend to judge distances better than men, regardless of education level. However, literature suggests that men may perceive out-of-sight objects and cardinal cues more readily in wayfinding route.

The focus of this study was the lack of information related to the variables of gender and ethnicity associated with memory of design features in the built environment. In this study, memory scores of design features were measured based on gender and ethnicity. In addition, an examination of wayfinding preferences based on gender and ethnicity were measured.

The significance of the study may have practical application. Understanding memory of design features in the built environment may identify areas in which design professional may improve the construction of buildings. In addition, knowing wayfinding preferences may also provide insight and information that can be used in life safety plans and evacuation models.

Summary of the Results

The study sought to answer the following research questions: (1) What are the demographic characteristics of individuals enrolled in Applied Health, Business Administration, Computer Aided Drafting and Design, Computer Animation and Game Design, Design Visualization, Interior Design, Legal Studies, Nursing, and Web Design and Development? (2) What is the frequency and percent for all participants' responses to memory of design features? (3) To what extent are there differences on memory of design features in the built environment based on gender and ethnicity? (4) What are the wayfinding preferences based on gender and ethnicity?

Question one addressed the demographic characteristics of individuals enrolled in Applied Health, Business Administration, Computer Aided Drafting and Design, Computer Animation and Game Design, Design Visualization, Interior Design, Legal Studies, Nursing, and Web Design and Development. Results of descriptive analyses revealed participants were almost equally divided by gender: 65 (50.4 %) were male and 64 (49.6%) were female. Of the 129 participants, 95 (73.6%) were 16–30 years of age, 17 (13.2%) were 31–40 years of age, 15 (11.6%) were 41–50 years of age, and 2 (1.6%) were 51–60 of age. Participants were primarily single. Of the 129 participants, 95 (73.6%) were single, 24 (18.6%) were married, 8 (6.2%) were divorced and 2 (1.6%) were widowed. The majority of participants were Caucasian. Of the 129 participants, 63 (48.8%) were Caucasian, 52 (40.3%) were Black/African American, 5 (3.9%) were Hispanic, and 9 (7.0%) were Other ethnicity. Of the 129 participants, 57 (44.2%) were Computer Aided Drafting and Design, 71 (55%) were Computer Animation and Game Design, and 3 (2.3%) were Computer Programming and Information Systems. Additionally, 94 (72.9%) of participants had other degrees including business management, nursing, and legal studies.

Question two investigated the frequency and percent of responses for all participants on memory of design features. Results of descriptive analyses revealed that overall, architectural design features were most often recalled by participants than any other design feature. Examples of architectural design features most often recalled were elevators (96.9%), windows (95.3%), stairs (90.7%) and columns (89.1%).

Memory of life safety design features most often recalled were windows (95.3%), stairs (90.7%) and emergency lighting (51.2%). Frequency and percent of other life safety features were fire extinguishers (20.9%), fire alarms (34.9%), evacuation maps (29.5%), and you-are-here maps (24.8%).

In terms of directional indicators, overhead signs (93.0%) were most often recalled rather than room numbers (35.7%). Other than chairs (93.8%), desks (89.9%), trash bins (72.9%) and sofas (79.1%), furniture, fixtures and equipment were not recalled as frequently as static objects such as permanent architectural design features.

Question three investigated whether or not there was a significant difference between the predictor variables of gender and ethnicity on memory of design features in the built environment. Results of the two-way analysis of variance indicated a statistically significant difference for the predictor variable gender and memory of design features in the built environment.

Question four identified wayfinding preferences based on gender and ethnicity. There were 11 wayfinding preferences listed for responses. Respondents were to mark always, frequently, sometimes, seldom, or never for each item. The mean score for all males was 32.39, with a standard deviation of 7.537; the mean score for all females was 24.60 with a standard deviation of 5.008.

Conclusions

To the extent that the data collected for this study were valid and reliable and the assumptions of the study were appropriate and correct, the following conclusions may be made. Based on the results of this study, it may be concluded that there were statistically significant differences for gender and memory of design features in the built environment. Additionally, it may be concluded that there were no statistically significant differences for gender and wayfinding preferences. However, there were statistically significant differences for ethnicity and wayfinding preferences in the built environment and a significant interaction effect for gender and ethnicity and wayfinding preferences.

Discussion

Environmental cognitive factors and properties of the physical environment that contribute to the formation of more accurate and complete cognitive maps must be incorporated into performance specifications. Because it is neither practical nor possible to list all building configurations, materials, and all surface finishes that promote better wayfinding and orientation, it may be necessary to specify the performance of buildings for wayfinding.

We must develop specifications that reflect the combined effect of building features on emergency egress and wayfinding processes. Cognitive accessibility can be a key measure of such performance. Just as we can specify a 4- or 3- our fire resistance-rated wall, we can specify the amount of time that building occupants will need to locate an exit for safe egress based on cognitive applications.

Research on memory factors that may affect wayfinding and exit access time could be explored. Memory factors may be specified as part of the performance criteria in the built environment. While wayfinding exit time in the built environment implies immediate access to and use of exits, exit access time makes a distinction between having physical and cognitive access to an exit and its actual use. It is this cognitive access and element that could be furthered examined.

We may also rate design elements cognitively. Design specifications require the grouping of building configurations, such as linear, concentric, or composite building configurations. Design professionals rate the degree of visual access to sections of a building and the physical distinctiveness of building parts and these principles are provided in the *Life Safety Code Handbook.* Thus, memory of design features and wayfinding preferences may affect life safety.

The relationship between the physical and social environment in which behavior occurs is complex. The situation is complicated by the individual's perception of ambiguous cues, which is primarily influenced by the person's relevant training and previous experience (Bryan, 2004, p. 30).

In addition, people may have a variety of limitations that increase their risk in the built environment: sensory problems, such as deafness or blindness; mobility problems that may entail the need for a wheelchair; and intellectual problems, such as mental retardation (Bryan, 2004, p. 23).

Recommendations for Future Research

The U.S. Census Bureau estimates that between now and 2050, the population of persons 65 and older will grow by more than 230%. This diverse population will grow from 12.7% of the population to over 20% of the population (U.S. Bureau of Census, 1997, 2000). It is estimated that between now and 2019, 75 million baby boomers will turn 55, and by 2011 the first wave of baby boomers will turn 65. By 2050, the Census Bureau projects as many as four million people over the age of 100, eight million people over the age of 90, and 20 million people over the age of 80.

This growing diverse market will need modifications to its environments for life safety. William (2001) determined that nearly 20% of respondents expressed a need for convenient and accessible floor plans in the built environment. Research participants wanted ease of navigation in interiors. Wayfinding may affect people daily and throughout their lifetime. Improving the conditions of navigation paths may help improve the quality of life.

There are several areas in need of future research. One area that especially may need further investigation is understanding the memory and wayfinding behavior of the older adult. There also seems to be a lack of information on wayfinding memory and spatial behavior of older adults. The growing population of older adults may dictate a need for more memory research in the built environment. There may be a demand for more accessible and user friendly interior environments. In addition, more information on the thought process versus the navigation process in wayfinding may be needed. The impact of new technology on wayfinding behavior could be investigated. Research on the impact of wayfinding "learning aids" to increase navigation skills for both younger and older adults may be necessary. Kirasic (1999a) and Barrash (1994) suggest that familiarity with wayfinding routes and landmarks may aid in increasing productivity for all ages. Therefore, interior design professionals need to identify ways to create environments that are more user friendly with navigation paths and are more accessible for everyone.

Limitations of the Study

The research for this study focused on memory of design features in the built environment based on gender and ethnicity. While the study focused only students and educators who attended Virginia College, the study could be replicated at other sites. The variables used in the two-way analysis of variance were gender and ethnicity. However, it might be useful to include a larger sample of age groups and professional backgrounds, and disabilities to determine if they are significant predictors of memory of design features and wayfinding preferences.

This study showed gender related differences for design features and ethnicity related differences for wayfinding preferences in the built environment. Useful information may be gained if the design features and wayfinding preferences were primarily focused on life safety in the built environment.

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APPENDIX A

AUBURN UNIVERSITY INSTITUTIONAL REVIEW BOARD (IRB) LETTER REQUEST FOR APPROVAL OF RESEARCH INVOLVING HUMAN SUBJECTS

Auburn University
Auburn University, Alabama 36849-5221

Educational Foundations,
Leadership, and Technology
4036 Haley Center

Telephone: (334) 844-4460
FAX: (334) 844-3072

(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS AN IRB APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)

INFORMATION LETTER
for a Research Study entitled
Memory of Individuals on Selected Design Features in Built Environments

Dear students, educators and administrators,

You are invited to participate in a research study to identify memory factors that may be related to gender, age, ethnicity, college major and years of professional work experience. The study is being conducted by Kristi Julian under the direction of Dr. Marie Kraska, Mildred Fraley Distinguished Professor, in the Auburn University Department of Education, Foundations, Leadership and Technology. You were selected as a possible participant because you may have knowledge of possible memory tendencies than can be generalized to a larger population and increase the body of research knowledge and are age 19 or older. As a result of participation in the study, it is hoped that you gain practical knowledge of memory factors and their effect in the built environment.

If you decide to participate in this research study, you will be asked to view a slide presentation and respond to a survey. I will provide you with a scantron form and ask you to respond to a survey in which you will assess memory of selected design features. Your total time commitment will be approximately 30 minutes.

No unreasonable risks or discomforts are anticipated by your participation in this study.

If you participate in this study, you may expect to add to the body of knowledge on the subject of memory and wayfinding in the built environment. We/I cannot promise you that you will receive any or all of the benefits described.

No direct monetary benefit should be expected from your participation in this study. However, it can be expected that any data obtained from this study will be used to support existing research or used as a model for future study on memory in the built environment.

There are no costs anticipated by your participation in this study.

The Auburn University
Institutional Review Board
has approved this document for use
from 3/22/09 to 3/21/10
Protocol # 09-085 EX 0903

Page 1 of 2

If you change your mind about participating, you can withdraw at any time during the study. Your participation is completely voluntary. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. You decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, the department of Education, Foundations, Leadership and Technology or Virginia College.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide will be password protected and known only to the investigator and Dr. Marie Kraska. Information obtained through your participation may be published in a professional journal or presented at a professional meeting.

If you have questions about this study, please ask them now or contact me later at deronkl@auburn.edu or at (205) 655-8293 or my major professor, Dr. Marie Kraska, at kraskmf@auburn.edu or at (334) 844-3806. A copy of this document will be given to you to keep.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334) 844-5966 or email at hsubjec@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO. THIS LETTER IS YOURS TO KEEP.

Kristi Julian

Investigator's signature Date 4/6/09

KRISTI JULIAN

Print Name

The Auburn University
Institutional Review Board
has approved this document for use
from 3/22/09 to 3/21/10.
Protocol # 09-085 EX 0903

APPENDIX B

SURVEY INSTRUMENT

Part II — MEMORY OF DESIGN FEATURES IN THE BUILT ENVIRONMENT

Section 1: The following questions address interior features of the building in the slide presentation just shown. **Code: A=Recall seeing B=Did not recall seeing**

1. Stone flooring
2. Elevator
3. Benches
4. Chairs
5. Plants/Shrubbery
6. Tables
7. Fire Extinguishers
8. Fire Alarms
9. Emergency lighting
10. Evacuation Maps
11. Bulletin Boards or Display Boards
12. Framed Art and Awards
13. Clocks
14. Portraits
15. Landscape Paintings
16. Drink and Snack Machines
17. Bathrooms
18. Room Numbers
19. Overhead Signs
20. You-are-here Maps
21. Windows
22. Water Fountains
23. Stairs
24. Trash Bins
25. Food
26. Drug Store
27. Sofas/Couches
28. Animals
29. Piano
30. Columns
31. Desks
32. Televisions
33. Newspaper stands
34. Wheelchairs
35. Flag
36. Flower arrangements
37. Sinks
38. Magazine racks
39. Escalator
40. Revolving Door
41. Patient comments
42. Animal portraits
43. Aquarium

Section 2: The following section addresses your wayfinding preferences.

44. I look to identify where evacuation maps are

A. ____Always
B. ____Frequently
C. ____Sometimes
D. ____Seldom
E. ____Never

45. A “you-are-here” map showing my location within the building would be useful to me

A. ____Always
B. ____Frequently
C. ____Sometimes
D. ____Seldom
E. ____Never

46. I notice if there is balance or a certain system in the building configuration

A. ____Always
B. ____Frequently
C. ____Sometimes
D. ____Seldom
E. ____Never

47. I look for landmarks (e.g. signs, shapes or colors) to help me find my way

A. ____Always
B. ____Frequently
C. ____sometimes
D. ____Seldom
E. ____Never

48. I usually feel confident giving directions to someone

A. ____Always
B. ____Frequently
C. ____Sometimes
D. ____Seldom
E. ____Never

49. Signs showing different parts of a building are useful to me

A. ____Always
B. ____Frequently
C. ____Sometimes
D. ____Seldom
E. ____Never

50. I pay attention to “numbering” on doors and signs

A. ____Always
B. ____Frequently
C. ____Sometimes
D. ____Seldom
E. ____Never

51. I think about where I am located within the building (i.e. north, south, east, west)

A. ____Always
B. ____Frequently
C. ____Sometimes
D. ____Seldom
E. ____Never

52. I use flooring patterns to help me find my way

A. ____Always
B. ____Frequently
C. ____Sometimes
D. ____Seldom
E. ____Never

53. I refer to color to help me find my way

A. ____Always
B. ____Frequently
C. ____Sometimes
D. ____Seldom
E. ____Never

54. I like hearing background sound (i.e. clocks ticking, water flowing from a water fountain, people talking) when I am finding my way

A. ____Always
B. ____Frequently
C. ____Sometimes
D. ____Seldom
E. ____Never

Section 3: Request for Demographic Information

55. Gender

A. _____Male
B. _____Female

56. Age range

A. ____16-30
B. ____31-40
C. ____41-50
D. ____51-60
E. ____61 and older

57. Marital status

A. ____ Married
B. ____ Single
C. ____ Divorced
D. ____ Widowed

58. Educational level completed

A. ____Some high school
B. ____Completed high school
C. ____Some college
D. ____Completed college

59. Ethnic background

A. ____White/Caucasion
B. ____Black/African-American
C. ____Hispanic
D. ____Asian or Pacific Islander
E. ____Other (please specify) ______________________

60. Major in college:

A. _____Interior Design
B. _____Computer Aided Drafting and Imaging and Visualization
C. _____Computer Programming and Information Systems
D. _____Culinary Arts
E. _____None of the above

61. Major in college:

A. _____ Applied Health/Medical
B. _____ Legal Studies/Law
C. _____ Administrative Office Management
D. _____ Business Management
E. _____ Other (Please specify) ________________________

1. Name of Hometown : _________________
2. Name of State: __________________________

THANK YOU VERY MUCH FOR YOUR PARTICIPATION AND YOUR HELP IN THIS RESEARCH. RAISE YOUR HAND WHEN YOU HAVE COMPLETED THIS SURVEY AND I WILL PICK IT UP FROM YOU.