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## Wayfinding in Unfamiliar Indoor Healthcare Environments: An Evidence Based Design Approach Using Gaze-Tracking Technology

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# Wayfinding in Unfamiliar Indoor Healthcare Environments: An Evidence Based Design Approach Using Gaze-Tracking Technology



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Watauga Medical Center, Appalachian Regional Healthcare System



Eye-Guide LLC



Appalachian State Research Office



# Introduction

## Importance of Wayfinding

Disorientation can cause **frustration, irritation, anxiety, and stress in healthcare environments** (Rousek & Hallbeck, 2011, Miller & Lewis, 2000, cooper, 2010, Leemes, 2010)

Wayfinding is a prerequisite for **autonomy, independence, self-sufficiency, and self-esteem.**

**Zimring (1999)**, 604 bed hospital, Annual cost of wayfinding: **\$220,000** for the main hospital.  
**Direct information giving by staff: 4,500 staff hours.**



# Literature Review

- Navigation within buildings involves **multiple cognitive processes**.
- **Form mental representations (cognitive maps)**. (Lynch, 1960 & Dominant Framework).
- Seek information from **multiple environmental cues** (Pati et al., 2014).

Pati et al., (2014):

- **Cognitive aspects** of wayfinding
- Unfamiliar healthcare Environment
- Verbal protocol

Ghamari et al., (2015)

- **Visual environmental elements of wayfinding**
- **Unfamiliar educational facility**
- **Same destination sequence**
- **Eye-tracking (eye-fixations)**

# Current Study Objective

Ghamari et al., (2016)-Current study

**Visual environmental elements of wayfinding**

**Unfamiliar healthcare facility**

**Eye-tracking (eye-fixations)**

**Randomized destination sequence**



**Objective of the Study:**

**To identify and rank-order visual environment elements in an unfamiliar healthcare environments that attract gaze fixation during wayfinding.**



- 1- What are the durations of eye-fixations on different visual environmental elements during wayfinding?**
- 2- Age groups?**
- 3- Gender differences?**



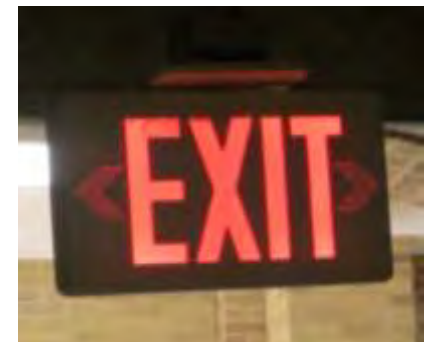
# Environmental Attributes of Wayfinding

## 1- Signs

alphanumeric and symbolic  
declarations of programmatic  
spaces, directions and routes.

Types of signage (Huelat, 2007):

- Directional
- Identifying
- Informative
- Safety and Regulatory



# Environmental Attributes of Wayfinding

## 2. Maps

Diagrammatic, two-dimensional representation



## 3. Lighting

Highlight hazards



## 4. Color

Distinguish between surface



## 5. Directories

Wayfinding tool



## 6. Functional Clusters

Clusters of programmatic spaces with supportive and/or complementary functions.



## 7. Furniture

Movable equipment with associated accessories



## 8. Architectural features

- External spaces from the interiors
- Multi-level interior views
- Directional signs in exterior spaces



## 9. Interior Elements Pairing

- Logical pairing of interior elements, with associated functions.



## 10. Other Design Elements

- Artworks, fixed furniture, millworks, display boards, vending machine, indoor plants, fire extinguishers



# Eye Movements

Of the five senses, **vision represents 80 percent of human perception** (Seiderman & Marcus, 1989).

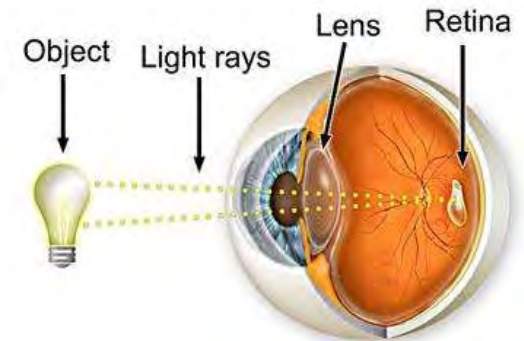
## Eye Movements:

### 1. Saccade

Consistent movement of the eye  
Different points of interest in the fovea

### 2. Fixation

The state between saccades where  
gaze position is fairly fixed.



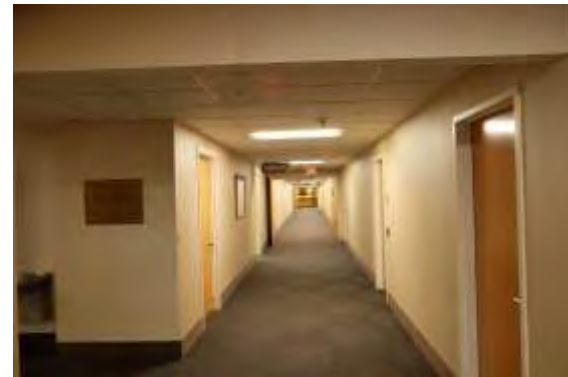
# Research Methodology- Subjects

- **24 subjects** (8 subjects in 3 age groups: **20-29**, **40-49**, and **60-69**)
- **Equal** males and females in each groups (**4 males and 4 females**).
- Subject in **sound health and have normal vision** (with or without glasses or contact lenses).
- None of the subjects had previously visited the **Watauga Medical Center (unfamiliar healthcare environment)**
- Subjects from a **common cultural context** (lived more than 10 years).



# Research Methodology- Setting

- **Watauga Medical Center, Boone, NC.**
- The hospital is a **4-story building** with a **centralized courtyard**.
- **Severe wayfinding problems and navigation errors.**
- **Under renovation and construction**



# Research Methodology- Destinations

Location	Point	Floor	Signage	Sources of Information	Comments
<b>Lobby</b>	<b>(O)</b>	First	N/A	N/A	Researcher will meet the subjects at this location and the tasks will end at this point.
<b>Radiology</b>	<b>A</b>	First	Most indicated	You are here Maps, Multiple signage on the main floor	The contribution of signage to the location of Radiology makes it easy to find according to the information of maps and signs.
<b>Patient Room 305</b>	<b>C</b>	Third	Majorly indicated	3 as the first digit of the room, which might indicate the location of the room on the third floor	While the room has not been indicated in the directory of the lobby, it is predicted that the subjects go to the third floor to find the room.
<b>Pain Clinic</b>	<b>B</b>	Second	Minorly indicated	Difficulty of finding of the destination because of the not properly position of the signage.	While there were some signage of this destination in the lobby, the sign was not properly located at the destination.
<b>2 West Waiting-Inpatient Surgery</b>	<b>D</b>	Second	Least indicated	Information on directories.	There is little source of information for this location.. The only sign of this destination located at the second floor on the west side of the building.
<b>Lobby</b>	<b>(O)</b>	First	N/A	N/A	The subjects go back to the origin point and finish their navigation tasks.



# Research Methodology- Destinations



(O)



(A)



(C)

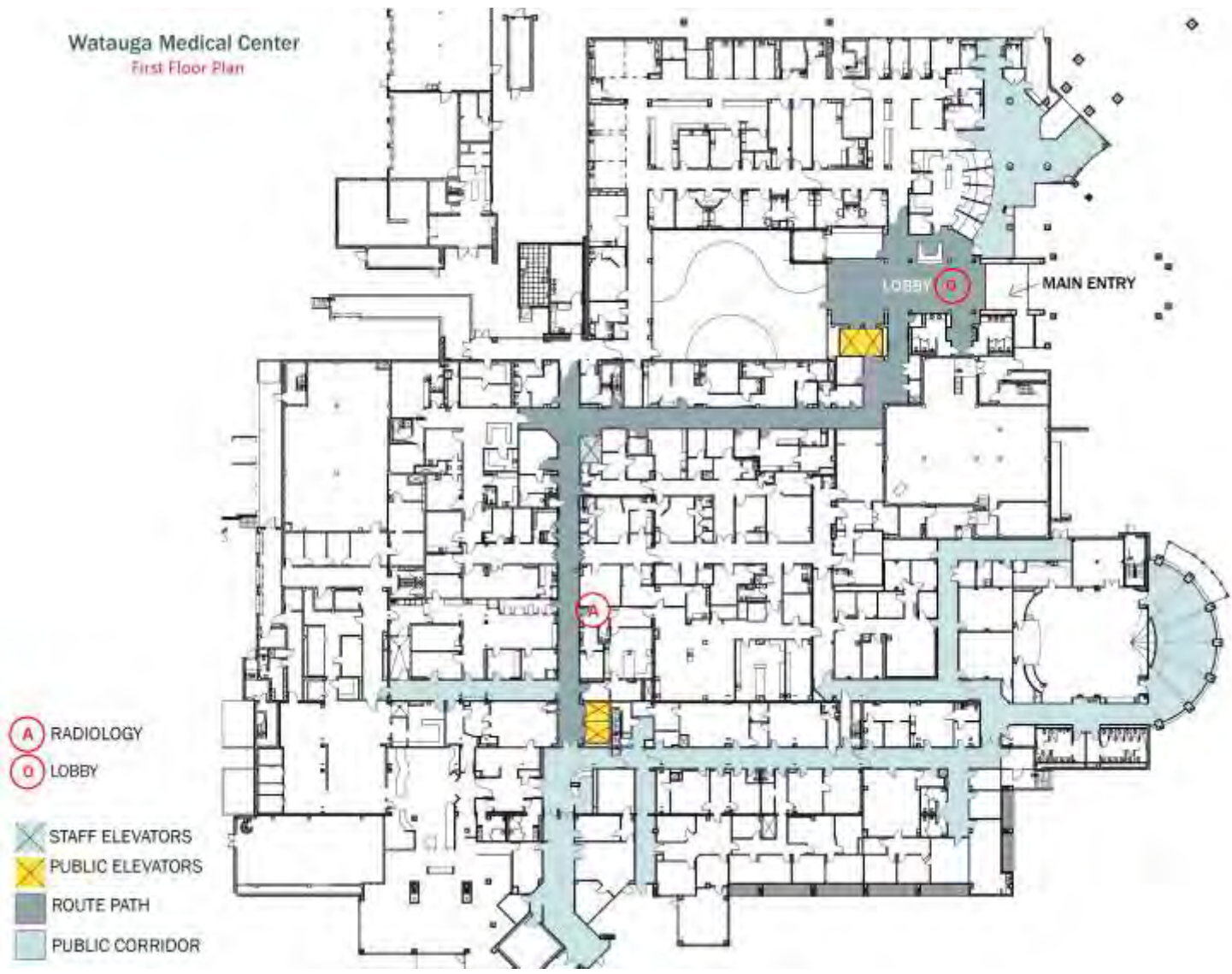


(B)



(D)

# Research Methodology- Setting



# Research Methodology- Setting



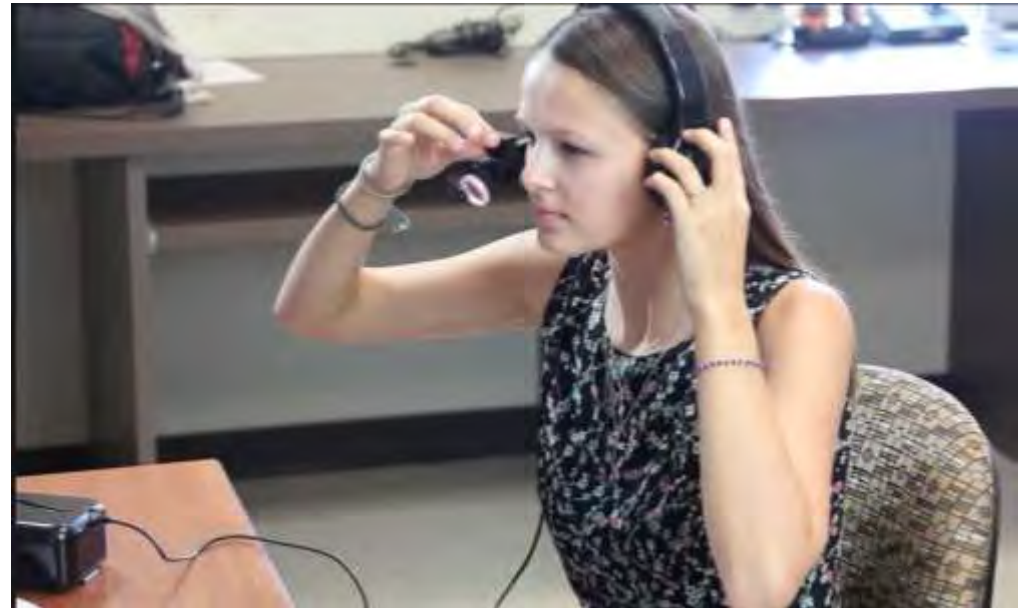
# Research Methodology

Watauga Medical Center  
Third Floor Plan



## EyeGuide Tracking Technology

<b>Interface Design</b>	<b>Video based headset</b>
<b>Eye-tracking</b>	<b>Monocular, Right eye</b>
<b>Gaze accuracy</b>	<b>0.5°</b>
<b>Data Rate</b>	<b>60 Hz</b>
<b>Calibration</b>	<b>9 point- Field and screen</b>
<b>Compatibility</b>	<b>Contact lenses or glasses</b>



# Research Methodology- Destinations

**Calibration:** Each destination

**Time limits:** 7 minutes

**Fail in finding the destination:** researchers guided the subjects to the next destination.

Researchers **walked behind the subject** during navigations.

**Randomization Sequence** for all participants

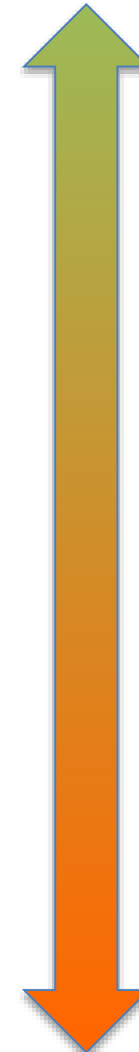
**No question** during navigations.



# Research Findings

Route	Participants	Succeeded	Failed	Mean Time (S)
B-O	6	6	0	36.6
A-O	6	6	0	63.8
D-O	6	6	0	77.3
D-C	6	6	0	104.5
B-A	6	6	0	104.5
D-A	6	6	0	112.8
C-O	6	6	0	113.6
O-A	6	6	0	115.83
A-C	6	6	0	116
C-A	6	6	0	123.8
D-B	6	5	1	141.8
O-C	6	6	0	146
B-C	6	6	0	149.1
B-D	6	6	0	154.3
C-B	6	5	1	188.1
A-B	6	5	1	194.6
C-D	6	6	0	216
O-D	6	4	2	251.6
A-D	6	5	1	263.5
O-B	6	4	2	290.1

Easiest



Going back to lobby

- Familiarity with environment

Easier/Faster/More successful Routes:

- Destinations A,C
- Both have the most contribution of signage, maps, and directories.

Harder/Slower/More Failed Routes:

- Destinations B,D
- Both destinations had the least contribution from env elements.

Most Difficult

# Research Findings - Q1 what are the durations of eye-fixations on different visual environmental elements during wayfinding?

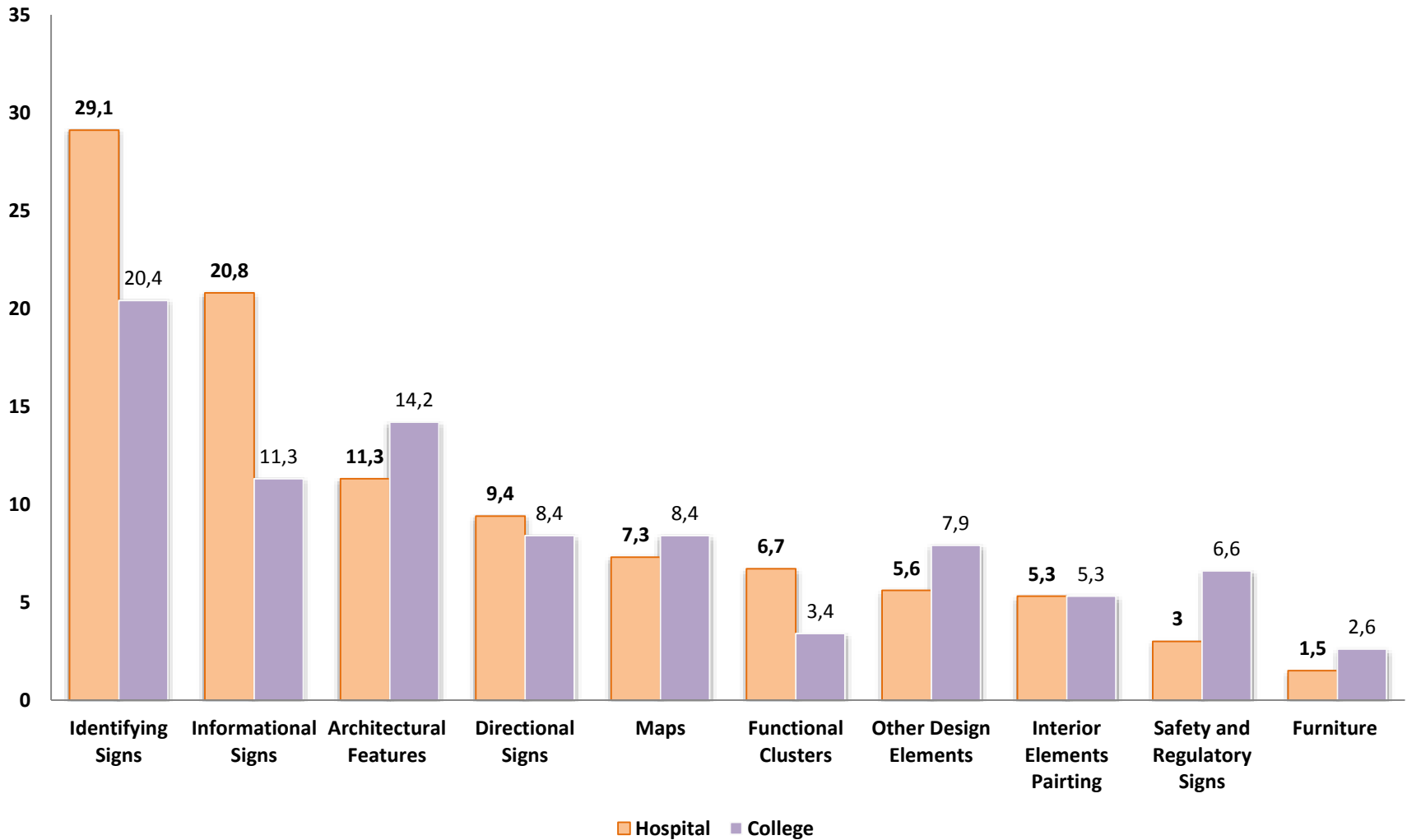
Visual Attributes	Eye-Fixations(ms)	Percentage
Identifying Signs	342556	29.1%
Informative Signs	245567	20.8%
Architectural Features	133232	11.3%
Directional Signs	110980	9.4%
Maps	85678	7.3%
Functional Clusters	78456	6.7%
Other Design Elements	65453	5.6%
Interior Elements Pairing	62345	5.3%
Safety and Regulatory Signs	35678	3.0%
Furniture	17895	1.5%
<b>Total</b>	<b>1177840</b>	<b>100%</b>

Major visual elements of Wayfinding

Signage: 62.3%



# Research Findings - Comparison with previous study



# Research Findings - Age Differences

## Time of Navigation:

**Post hoc** Tests: Tukey HSD: Young age group ( $M = 826.5$ ,  $SD = 83.2$ ) was significantly different than the elderly group ( $M = 945.8$ ,  $SD = 84.2$ ).

## Eye-fixations on Visual Environmental Attributes:

No significant difference.

## **Time of Navigation:**

Results of the independent sample t-test show that mean time of navigation differed between males ( $M = 834.3$ ) and females ( $M = 899.3$ )

## **Eye-fixations on Visual Environmental Attributes:**

**No significant difference between males and females.**

## Eye-tracking Limitations

- Captures a 90 degree field-of-view not peripheral vision
- Calibrating and tracking only the right eye (monocular eye- tracking) instead of the both eyes (binocular eye-tracking).

## Other variables

- Noise, smell, number, and type of people in the environment.

## Success in Wayfinding:

**The more the destination was indicated by environmental attributes/elements, the easier** the participants could find their destinations.

## Age and Gender Differences:

**Males** were **faster** than **females** in finding the destinations .

**Young age groups (20-29)** were **faster** than the **elderly group (60-69)** of the participants.

Health Impact?

# Conclusion



Health  
Outcome  
impact?



# THANK YOU!

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