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

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Eye-Guide LLC

Appalachian State Research Office
Importance of Wayfinding


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.


- Seek information from multiple environmental cues (Pati et al., 2014).
Previous Studies- Environmental Attributes of Wayfinding

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)
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.
Research Questions

1- What are the durations of eye-fixations on different visual environmental elements during wayfinding?

2- Age groups?

3- Gender differences?
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
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 group (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).
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

<table>
<thead>
<tr>
<th>Location</th>
<th>Point</th>
<th>Floor</th>
<th>Signage</th>
<th>Sources of Information</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lobby</td>
<td>(O)</td>
<td>First</td>
<td>N/A</td>
<td>N/A</td>
<td>Researcher will meet the subjects at this location and the tasks will end at this point.</td>
</tr>
<tr>
<td>Radiology</td>
<td>A</td>
<td>First</td>
<td>Most indicated</td>
<td>You are here Maps, Multiple signage on the main floor</td>
<td>The contribution of signage to the location of Radiology makes it easy to find according to the information of maps and signs.</td>
</tr>
<tr>
<td>Patient Room 305</td>
<td>C</td>
<td>Third</td>
<td>Majorly indicated</td>
<td>3 as the first digit of the room, which might indicate the location of the room on the third floor</td>
<td>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.</td>
</tr>
<tr>
<td>Pain Clinic</td>
<td>B</td>
<td>Second</td>
<td>Minorly indicated</td>
<td>Difficulty of finding of the destination because of the not properly position of the signage.</td>
<td>While there were some signage of this destination in the lobby, the sign was not properly located at the destination.</td>
</tr>
<tr>
<td>2 West Waiting-Inpatient Surgery</td>
<td>D</td>
<td>Second</td>
<td>Least indicated</td>
<td>Information on directories.</td>
<td>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.</td>
</tr>
<tr>
<td>Lobby</td>
<td>(O)</td>
<td>First</td>
<td>N/A</td>
<td>N/A</td>
<td>The subjects go back to the origin point and finish their navigation tasks.</td>
</tr>
</tbody>
</table>
Visual Environmental Attributes/Elements of Wayfinding in Unfamiliar Healthcare Environments

Research Methodology- Destinations

(O)

(A)

(C)

(B)

(D)
Research Methodology - Setting

Visual Environmental Attributes/Elements of Wayfinding in Unfamiliar Healthcare Environments
Research Methodology - Setting
Visual Environmental Attributes/Elements of Wayfinding in Unfamiliar Healthcare Environments

Research Methodology
Research Methodology - Instrumentation

EyeGuide Tracking Technology

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

Visual Environmental Attributes/Elements of Wayfinding in Unfamiliar Healthcare Environments
**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

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

### 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.

### Most Difficult
- Harder/Slower/More Failed Routes:
  - Destinations B,D
  - Both destinations had the least contribution from env elements.
**Research Findings - Q1** What are the durations of eye-fixations on different visual environmental elements during wayfinding?

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

Major visual elements of Wayfinding Signage: 62.3%
Visual Environmental Attributes/Elements of Wayfinding in Unfamiliar Healthcare Environments

Research Findings - Comparison with previous study

<table>
<thead>
<tr>
<th>Category</th>
<th>Hospital</th>
<th>College</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifying Signs</td>
<td>29.1</td>
<td>20.4</td>
</tr>
<tr>
<td>Informational Signs</td>
<td>20.8</td>
<td>11.3</td>
</tr>
<tr>
<td>Architectural Features</td>
<td>11.3</td>
<td>14.2</td>
</tr>
<tr>
<td>Directional Signs</td>
<td>9.4</td>
<td>8.4</td>
</tr>
<tr>
<td>Maps</td>
<td>7.3</td>
<td>8.4</td>
</tr>
<tr>
<td>Functional Clusters</td>
<td>6.7</td>
<td>3.4</td>
</tr>
<tr>
<td>Other Design Elements</td>
<td>5.6</td>
<td>7.9</td>
</tr>
<tr>
<td>Interior Elements Painting</td>
<td>5.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Safety and Regulatory Signs</td>
<td>3</td>
<td>6.6</td>
</tr>
<tr>
<td>Furniture</td>
<td>1.5</td>
<td>2.6</td>
</tr>
</tbody>
</table>
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.
Research Findings - Gender Differences

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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