#### **Navigation and Landmark Use**

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- Introduction
- Eye tracking, strategies and sex differences in virtual navigation
- Anderson, Dahmani, Konishi, Bohbot (2012)
  Landmarks' use in speech map navigation tasks

Roger, Bonnardel, Le Bigot (2011)

Outlook

#### Introduction

#### Wayfinding

- Using landmarks
  - Recognisable features
- Euclidian navigation
  - Distance
  - Angles
  - Cardinal directions

#### **Questions of Interest**

- How are these strategies used?
- What navigational strategy do people prefer?
- Does performance vary by strategy?

# Eye tracking, strategies and sex differences in virtual navigation

Anderson, Dahmani, Konishi, Bohbot (2012)

#### Background

- Past research differences in navigational ability between men and women
  - Different methods  $\rightarrow$  different findings
  - Women landmarks
  - Men euclidian

## Hypothesis

 If the ability to remember previously visited places depends on the type of information used in the environment, this should be reflected in the distrubution of gaze.

#### **Predictions**

- If men use euclidian measures, they should look at landmarks less frequently and for a shorter duration than women.
- Conversely, if women rely primarily on landmarks, they should look to landmarks more frequently and for longer than men.
  - They should exhibit inhibited performance in absence of landmarks.



- Participants
  - 4 men, 3 women between 21 and 37, mean age of 28.17
- Virtual environment with eye-tracking

# **The Virtual Environment**

- Central platform branching into 8 paths
- 5 distinct virtual environments containing 0, 2, 4, 6, or 8 landmarks
- Presented in the same semi-random order to all participants





- 3 trials in each environment → 15 total per participant
- 2 parts to each trial
  - (1) 4 of 8 open pathways containing an object
  - (2) 8 of 8 open pathways
    - 4 new ones contain an object
    - 4 visited no longer contain an object



- Eye movements tracked with ASL 504 Remote Mounted Camera
  - Uses retinal retroreflection and corneal reflectivity to plot eye angle relative to a stimulus
- 64 cm from navigation screen
- screen at eye level
- 30 frames per second for 125 minutes → 225 000 frames



#### • Per frame:

- Did gaze fall on a landmark?
- Fixation criteria:
  - Within zone equal to 50% of landmark's size
  - For 3+ consecutive frames (100+ ms)
- Per trial
  - Examine gaze per landmark
    - 100% / number of landmarks (2, 4, 6)
    - 40% (8)
    - Landmark utilised if at or over threshold

## Video Game Experience

- Video game experience did NOT correlate with:
  - Sex
  - Strategy
  - Time
  - Number of fixations

- In general women
  - took longer to complete the task on a given trial
  - Made more errors than men
- No sex differences in 8 landmark condition
- Women's performance decreases as landmarks decrease
- Women made more errors per trial than men in 0-landmark condition only





# Results – Navigational Errors



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# Conclusion – Navigational Performance

- Women made more errors and took more time to complete the task than men
  - Effect modulated by number of available landmarks
    - Women performed less well than men in the absense of landmarks (equally well with)
- Differences in brain activation patterns found Gron, Wunderlich, Spitzer, Tomczak and Riepe (2000)
- Conclude: Women make more use of landmarks than men

# **Results – Gaze and Navigation**

## **Results – Gaze and Navigation**

- Women made more landmark fixations than men
  - More fixations by women than men in 2- and 6-landmark trials
- Number of fixations correlated with amount of time to complete task (all conditions)
- No difference between men and women in number of fixations or landmark use

# **Eye Movement Differences**



# **Eye Movement Differences**



# Conclusion – Gaze and Navigation

- Women's performance more affected by absence of landmarks
  - → sex differences in use of visual information for navigation
- Total number of fixations higher in women, but proportion of resource use equal between women and men

 $- \rightarrow$  could explain latencies in previous work

# Conclusion – Gaze and Navigation

- Differences in decreases in landmark fixation with habituation
  - → women spend more time acquiring landmark related visual information
    - → may explain differences in speed found in past studies
- Men make fewer errors navigating a virtual environment with 0 landmarks
  - Probably due to differences in landmark use

# Results – Navigational Strategies

# **Navigational Strategies**

#### Spatial

- Construction of cognitive map of environment with relative positions of landmarks
- Response
  - Learning a sequence of body movements in response to a stimulus, ie a starting position, an environmental feature
- Determined based on 'detailed verbal reports'

# Results – Navigational Strategies

- Equal proportions of men and women
  - Used a spatial strategy (55%)
  - Used a response strategy (45%)
- Increase in use of a response strategy throughout experiment
  - Equal proportionally for men and women
    - Spatial: 8 (men), 6 (women)
    - Response: 16 (men), 12 (women)

#### **Spatial vs Response Learners**



## **Results – Gaze and Strategies**

- Spatial learners had greater resource use than response learners
- Spatial strategy → longer total duration of landmark fixations on first, but not subsequent trials (compared to response strategy)

# Conclusion – Navigational Strategies

- No interaction between sex and navigational strategy
- Spatial learners may look to landmarks more during initial trials while forming a cognitive map

# Results – Environmental Landmarks

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- Participants of both sexes spent < 10% of time looking at landmarks (resource use)
- Resource use increased with number of landmarks, levelling off at 6 landmarks
- Number of landmarks participants reported using increased with number of landmarks available
- Spatial strategists reported using landmarks more

## Results – Environmental Landmarks

- Resource use decreased significantly throughout the experiment
  - Significant negative correlation for men
  - No significant correlation for women

# Conclusion – Environmental Landmarks

 Women continue to use landmarks despite habituation

# Further Questions and Improvements

- More coherent inclusion of spatial and response strategies.
- More explicit discussion of types of errors.
- Only 7 participants.
- Potential confound:
  - does more fixation really lead to longer completion time,
  - or does longer time in the maze lead result in more fixations

# Landmarks' use in speech map navigation tasks Roger, Bonnardel, Le Bigot (2011)

# **Background: A-GPS**

- Assisted global positioning system
- Mobile phones
- Driver and pedestrian
- Relatively little use of landmarks so far

# **Purpose of the Study**

- Better understand role of landmarks in human navigation
  - Performance
  - Preference
- Determine frame-of-reference to be used in over-the-phone guidance systems
- How: route description task using Wizard-of-Oz paradigm



- Use of landmarks in navigational systems improves accuracy and satisfaction.
- Neutral landmarks improve performance and satisfaction over addressee-centred landmarks.

#### **Predictions**

- Participants will make fewer errors, take less time to perform a navigation task, and experience greater satisfaction when provided with landmarks as opposed to without landmarks.
- Use of addressee-centred landmarks will lead to more errors, longer performance time, and less satisfaction of neutral landmarks.

# Wizard-of-Oz Paradigm

- Instructions are given by a human simulating the functionalities of an automatic guidance system
- Participants do not know that the system is simulated
- 27 participants
  - 14 men
  - 13 women

- Steps that must be followed from location A to destination B on a laminated map
- 10 event maps, one for familiarisation
  - 3 trials with each
- Modified with markers representing landmarks
  - Experimental mentioned
  - Extra unmentioned

#### Analyse drawing actions:

- Total number (including corrections)
- Efficient actions (total minus corrections)
- Satisfaction feedback



- Instructions synthesized using SPOweb
- 3 experimental conditions:
  - 1) Adressee-centred landmark
    - 'Turn into the second hallway, the cloakroom will be on your left'
  - 2) Neutral landmark
    - 'Turn into the second hallway, there will be a <u>a cloakroom close by</u>'
  - 3) No landmark
    - 'Turn right into the second hallway that bears off the left'

#### 3 routes per map, 5 instructions each

Position	Instruction	Type of instruction
1	Go straight ahead	Not manipulated
2	Turn left into the second hallway, you will see the rest room	Experimental
3	Turn right into the first hallway	Not manipulated
4	Take an immediate left, you will see an information centre close by	Experimental
5	Turn right into the first hallway	Not manipulated
6	You have now arrived at the recreation room	Not manipulated

- Participants could use 5 vocal commands
  - Repeat
  - Next
  - Previous
  - Summary
  - Restart

# Hypothesis

- Landmarks improve navigation efficiency and satisfaction
- Landmark frames-of-reference have an effect on efficiency and satisfaction
- Time to navigate and errors should decrease with use of landmarks



- Each participant and 'Wizard' was equipped with landphone and headset, recorded
- Participant was recorded with a camera
- No eye-tracking

- Errors and Hesitations
  - No landmarks → more errors and hesitations
  - No significant difference between addressee-centred and neutral landmarks
- Drawing marks and completion time
  - No landmarks → more drawing actions and longer completion time
  - No significant difference between addressee-centred and neutral landmarks

 Unlike predicted, use of addressee-centred landmarks did not decrease performance and satisfaction.

Means (and Standard Deviations) for navigation performances according to instruction formulation (type of landmarks).

	Addressee-centered landmarks	No landmarks	Neutral landmarks
Directional errors	1.06 (.93)	1.84 (1.09)	1.05 (.90)
Completion time	83.40 (21.65)	92.73 (30.88)	79.6 (20.55)
Hesitations	1.39 (.70)	1.65 (.93)	1.24 (.66)
Drawing actions	9.12 (1.43)	10.06 (2.32)	9.29 (2.09)

## **Results - Satisfaction**

#### With landmarks yields higher satisfaction than no landmarks

Means (and Standard-Deviations) for satisfaction measures according to instructions' formulation (type of landmark).

	Addressee-centered landmarks	No landmarks	Neutral landmarks
General satisfaction (max 15)	12.72 (1.16)	11.78 (1.45)	12.74 (.99)
Amount of information (max 5)	4.03 (1.03)	3.76 (1.12)	3.96 (1.15)
Formulation preferences (mean position)	3.34 (.50)	1.59 (.48)	2.41 (.54)

## Conclusion

#### Landmarks

- Increase performance
- Increase satisfaction

#### **Further Questions**

#### Addresse-centred versus neutral landmarks

#### **Questions of Interest**

- How are these strategies (euclidian/landmark-based) used?
  - Reliance on landmarks when available
  - Equal looking to landmarks between men and women
  - Lack of landmarks appears to increase errors in women's navigation but not men's

#### **Questions of Interest**

- What navigational strategy do people prefer?
  - Prefer landmarks
- Does performance vary by strategy?
  - Inclusion of landmarks in directions improves task performance times
  - Use of landmarks reduces error

# Further Questions and Improvements

- Add directions to Experiment 1
  - How does gaze vary with directions? Using landmarks? Without landmarks?
- Add eye-tracking to Experiment 2
  - Do people fixate on landmarks?
  - Gaze patterns?
  - Possibly implement experiment 2 in a virtual setting.
- Differences across age groups? Experience? Cultures? Etc.

#### **Practical Applications**

 Include a landmark-based option in navigational systems.

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