Landmark-Based Pedestrian Navigation Processes

- An Eye Tracking Study -

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Introduction

- Navigation in an unfamiliar environment is a challenging mental process

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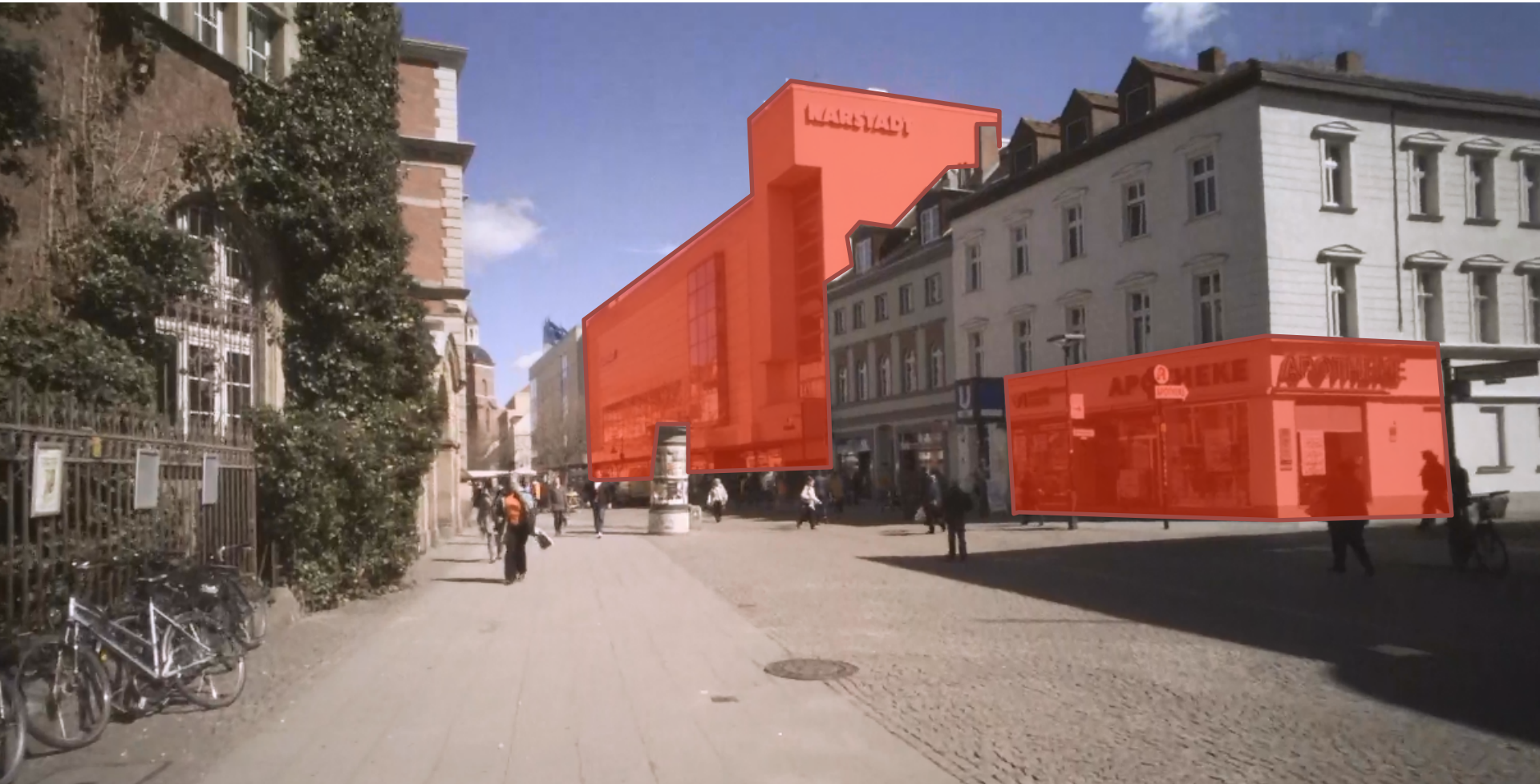
- Landmarks are intuitively perceived and used for navigation



Introduction

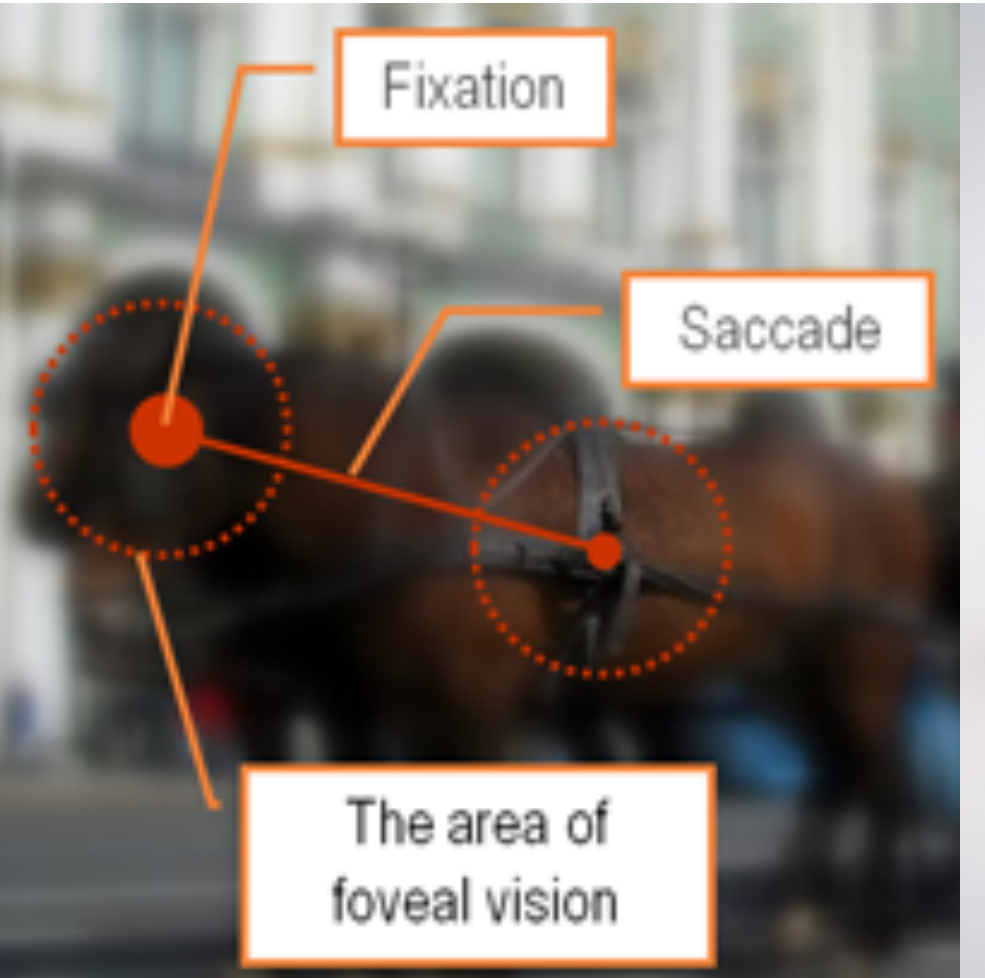
- Maps are used for navigation purposes
- Investigate cognitive effect of map content, in particular landmarks

Introduction

- **User perspective** in a real environment

Introduction

- **User perspective**: mobile eye tracking technology



Introduction

- **User perspective**: mobile eye tracking technology
- Eye-Mind-Assumption: **longer fixation = intensive mental processing**

Objective

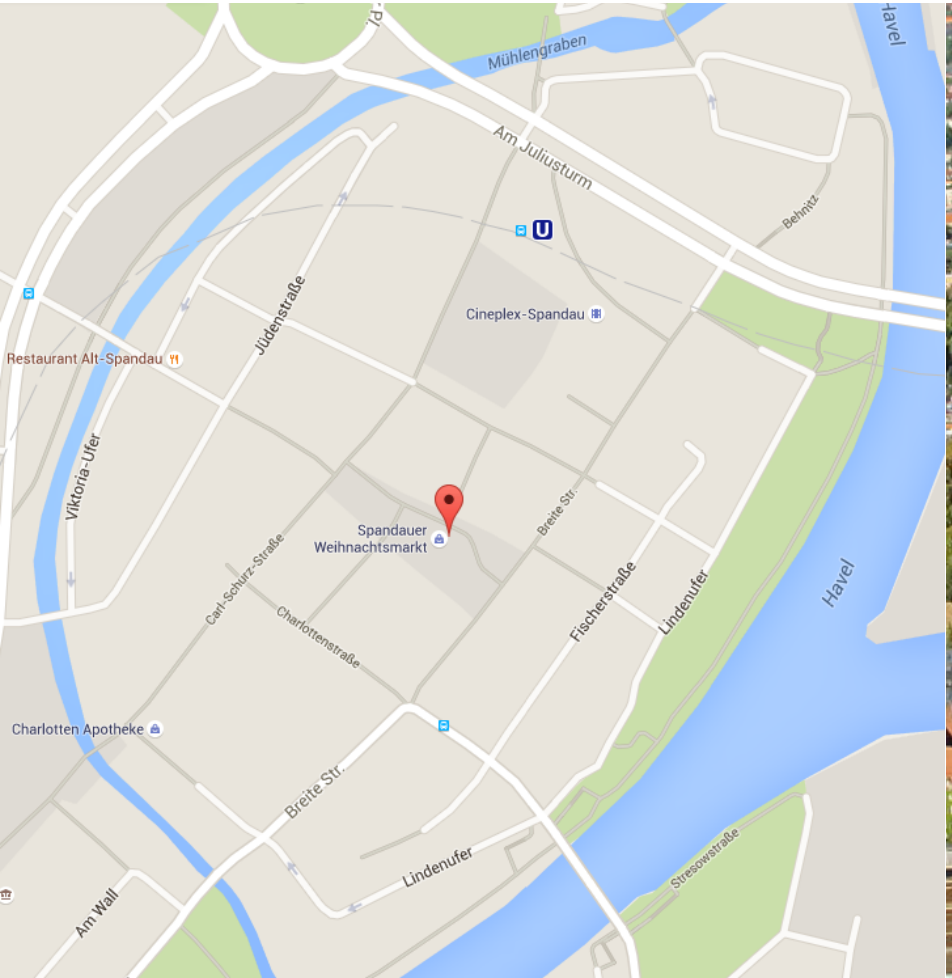
Investigation of local landmarks from a **viewer perspective**, to identify map content which stimulates the landmark knowledge and **spatial thinking.**

Research questions

1) Are objects **fixated longer** and more **frequently** when there is a change in direction and are they transferred to the **landmark knowledge**?
2) How often is the map used as a **navigational aid** when finding the way?
3) Is the **sustainability of landmark knowledge** improved by visualizing landmarks on maps?

Study design

- 20 participants in an unknown environment: Berlin Spandau old town



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- 20 participants in an unknown environment: Berlin Spandau old town
- Two groups (landmark group 3 women; control group 5 women)
- 1. Part:
  - Task: Navigation + Eye tracking (Fixations)
  - Interviews (with a featureless map) **WITHOUT using street names**
- 2. Part:
  - Memory test two weeks after the out door navigation task

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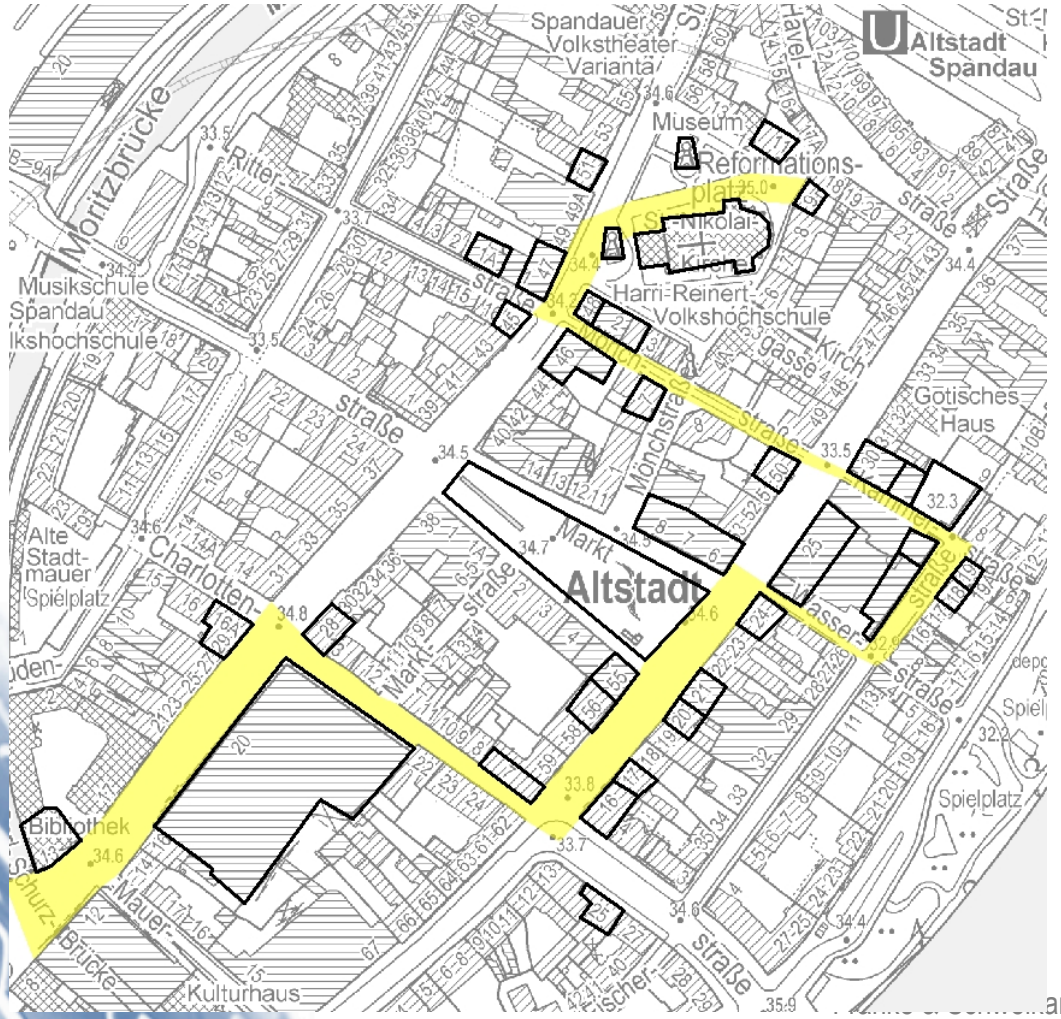
Results 1: Interview

- 37 different landmark objects were named 153 times



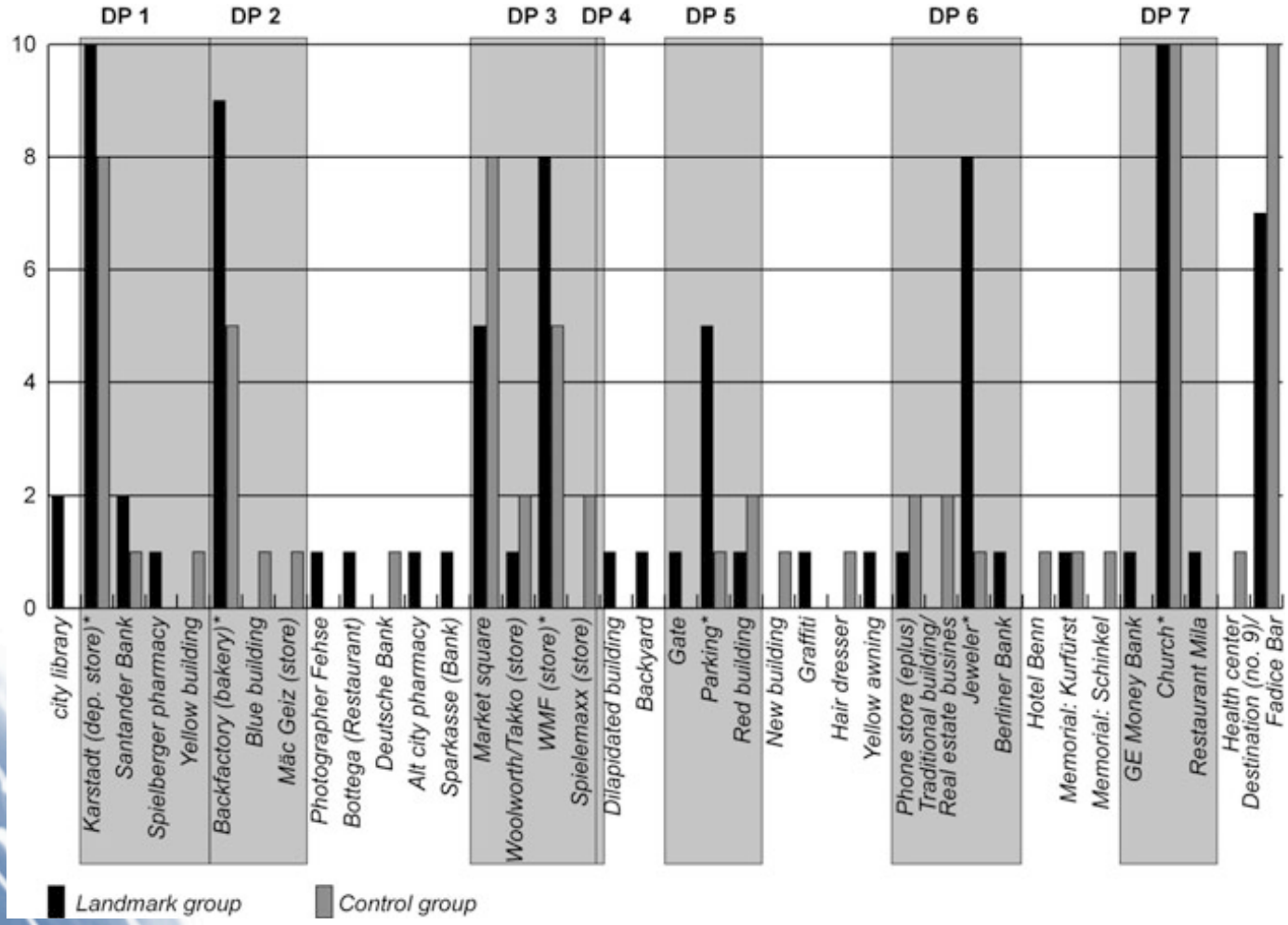
Results 1: Interview

- 37 different landmark objects were named 153 times

	Landmark group	Control group
Number of different landmarks	27	24
Ø Landmark recalls per interview	8.3	7.0

Results 1: Interview

- Landmarks recalls along the route



Results 2: Eye tracking

- Fixation duration on landmark objects

Average fixation duration per participant	Landmark group	Control group
On a landmark*	409 ms	599 ms
On other objects with at least one fixation	236 ms	209 ms

** Objects named in the interview*

Results 2: Eye tracking

- Fixation counts on landmark objects

Average fixation counts per participant	Landmark group	Control group
On a landmark*	2.45	3.89
On other objects with at least one fixation	1.66	1.29

** Objects named in the interview*

Results 2: Eye tracking

- Navigation performance: Fixation duration on map (Landmark group)

Map usage	Ø Fixation duration per participant
Landmark group	16.8 sec.

Results 2: Eye tracking

- Navigation performance: Fixation duration on map (Control group)

Map usage	Ø Fixation duration per participant
Landmark group	16.8 sec.
Control group	29.5 sec.

almost twice as much

Results 3: Memory test

	Located correct	Located wrong	Memory without location	No memory
Landmark group	6.2	1.4	4.8	10.8
Control group	3.3	4.7	5.3	10.4

- Correct located objects: **Difference between groups** is significant (Kruskal-Wallis test: p=0.05)

Results 4: Eye-Mind-Assumption

- Spearman's rank correlation analysis between landmark recalls and eye movements (**Eye-Mind-Assumption confirmed**)

	Landmark-recall/Fixation-duration (ms)	Landmark-recall/ Fixation-count
Landmark group	0.670**	0.674**
Control group	0.584**	0.601**

*(** p < 0,01)*

Conclusion 1

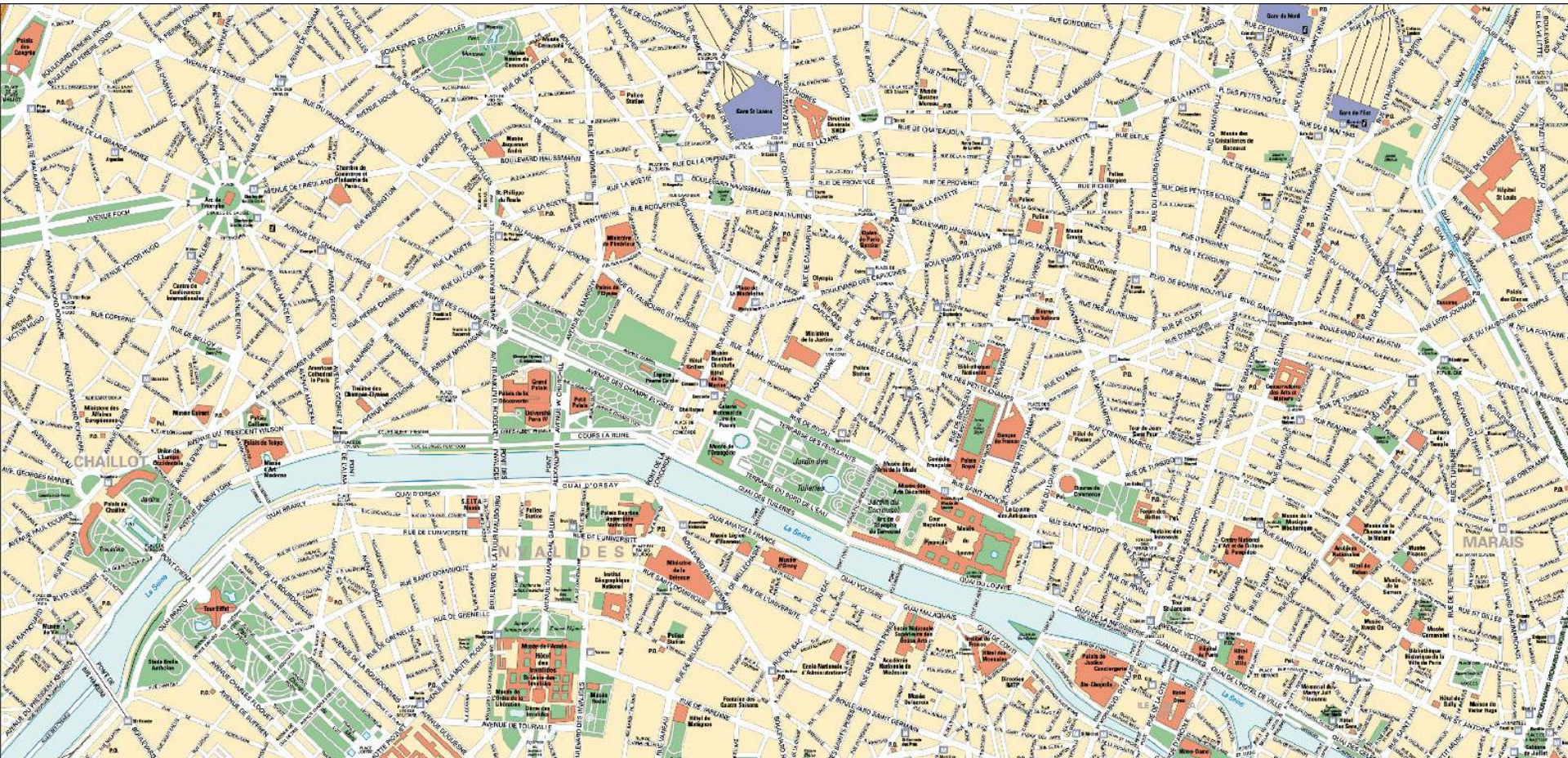
Eye-Mind-Assumption was confirmed in a real world environment …

… **because**: Objects, that are focused longer are more probably mentally processed

Conclusion 2

Visualization of landmark icons on maps…

… creates a more detailed **mental image** of the environment
because: more landmarks are recalled during the interview



Conclusion 3

Landmark icons on maps …

… improve the navigation performance,
because: the map is used less often as an navigational aid

Conclusion 4

Landmark icons on maps …

… improve the sustainability of information in a mental map,
because: significantly more landmarks are recalled and located correctly

Summary

The results show that landmarks on maps ...

- ✓ … improve navigation processes
- ✓ … improve both short-term and long-term the landmark knowledge and the mental storage of spatial information.

Thank you for your attention