Development of methods for the analysis of movement and orientation behaviour in wayfinding tasks based on the case study „mirror maze“

Universität Hamburg

Sven Heinsen
University of Hamburg
Institute for Psychology II
Methods & Cognitive Psychology

sven.heinsen@uni-hamburg.de

Navigation, orientation – to find one's way – belong to the elementary tasks of everyday life. Do behavioural data retrieved from these scenarios allow for a prediction of whether a subject is anxious, disoriented, determined or satisfied? Can behaviour be predicted on these bases? Insights like this might be of great use, for example for the optimisation of public spaces.

Goal of this work is a) the development of methods for the collection of data concerning subject's movement and orientation and b) the development of helpful descriptive measures, means of visualisation and analysis of this data.

Pre-study: virtual worlds

In a series of pre-studies, virtual 3D-rooms were developed to confront subjects with different experiences and to collect the resulting behaviour and orientation data.
To test technical aspects and for the explorative analysis of the movement and orientation data, a simple maze (fig. 1) and a supermarket scenario with various shopping functions (fig. 2) were implemented.
The focus of this work was on developing ways to collect and visualize movement and orientation data. We are now able to automatically collect these data online and to visualize them adhoc (fig. 1 and 3).
Virtual (desktop) environments allow the easy and exact collection of data. But how does the interface influence subjects' behaviour? What is measured in this setting, the navigation behaviour or subjects' competence in operating the computer-interface? In the first tests, subjects with little experience with 3D-environments turned out to have difficulties operating the system, thus focussing their attention primarily on the controls. Based on these experiences, the question of how movement and orientation data can be recorded in an easy, exact and affordable way in real environments came up.

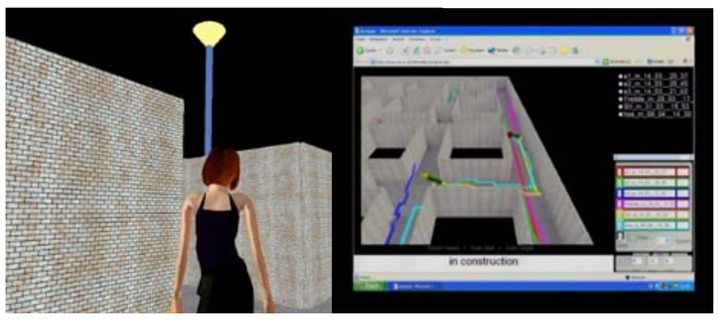

Figure 1: 3D maze and adhoc visualisation of position data, both accessible online.

Figure 2: Complex online scenario with different shopping functions.

Figure 3: Visualisation of movement and orientation data of the online maze as Quiver-Plot.

A facile method for recording movement and orientation behaviour in real indoor environments

In case of the method described here, movement and orientation behaviour is recorded by two head-mounted cameras. One camera records the subject's field of vision from an ego-perspective, while the second camera records a compass, which is mounted on the subject's head (fig. 4). With special software (MediaAnalyzer) the information derived from the videos can be transformed into digital coordinates. The subject's position is manually transferred to a 2D-plan frame by frame from the ego-perspective video, while turns of the head (orientation) are automatically analyzed. This leads to a detailed digital representation of the navigation behaviour, which can be used for further analysis. The described method is cost saving and applicable in most settings.

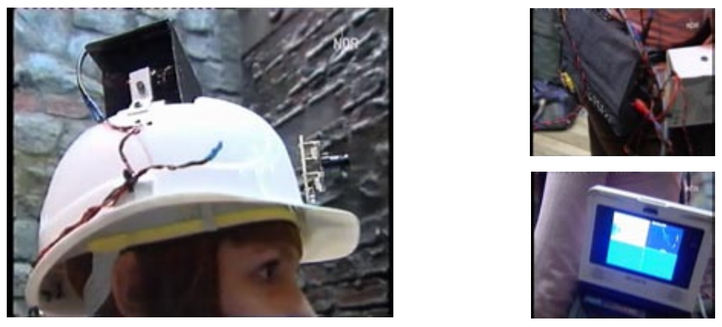

Figure 4: Equipment for the recording of movement and orientation behaviour (compass and second camera are mounted in the black box).

Case Study

Sex-based differences in wayfinding and navigation tasks have received broad attention from researchers.
Czerwinski (2002) und Tan (2003) have conducted research on performance differences related to the width of the visual field in virtual environments. They were able to proof, that the weaker performance of female subjects compared to male subjects in virtual environments was compensated when the field of vision was extensively widened.
The research of sex-specific differences was primarily focused on performance differences so far. Less attention was paid to detailed differences in behaviour.
The anticipation of a robust effect of sex and the opportunity to study detailed differences in behaviour and strategy of male and female subjects made this an ideal case study.
In addition to general strategic differences, the consequences of a reduction of the field of vision were tested. An interaction of reduced field of vision and sex of subject was expected to occur. Female subjects were expected to react to the reduced field of vision with a higher rate of compensational head turns.

Figure 5: Mirror-maze of the Hamburg Dungeon.

The mirror-maze of the Hamburg Dungeon, designed by Adrian Fisher (Adrian Fisher Mazes Ltd), was used as a test-setting (fig. 5 and 5a). 30 men and 30 women, half of the subjects with and half of them without experimental glasses reducing their field of vision (fig 6).
During the experiment, subjects' activities were recorded with the camera system described above. Additionally, subjects were instructed to think aloud during the experiment.

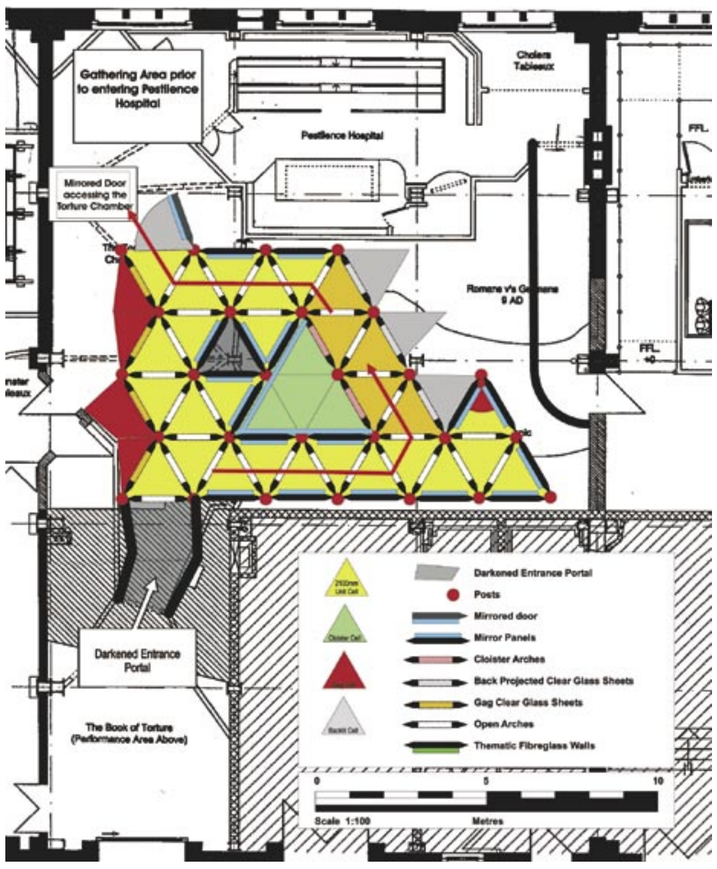

Figure 5a: Mirror-maze of the Hamburg Dungeon, ground plan (copyright: Adrian Fisher Mazes Ltd.).

Figure 6: Two of the four experimental conditions: female subject with restricted field of vision, male subject with unrestricted field of vision.

Experiment: main tasks

1. Exploration: First, subjects were asked to explore the maze as well as possible. After 4 minutes the subjects were asked to return to the entrance of the maze, but not to leave it. This task was meant to induce explorative behaviour.

2. Acoustic signal: Subjects had to find the source of an acoustic signal as fast as possible. The length of this episode was variable, resembling a performance test.
This task was meant to induce goal-oriented search under moderate time pressure.

3. Search for the exit: After subjects had turned off the signal, they were asked to find the exit of the maze which was not identical to the entrance. Due to the fact, that the exit was hidden behind a mirrored sliding door, it was not found in most cases.
This task was meant to produce moderate frustration and helplessness.

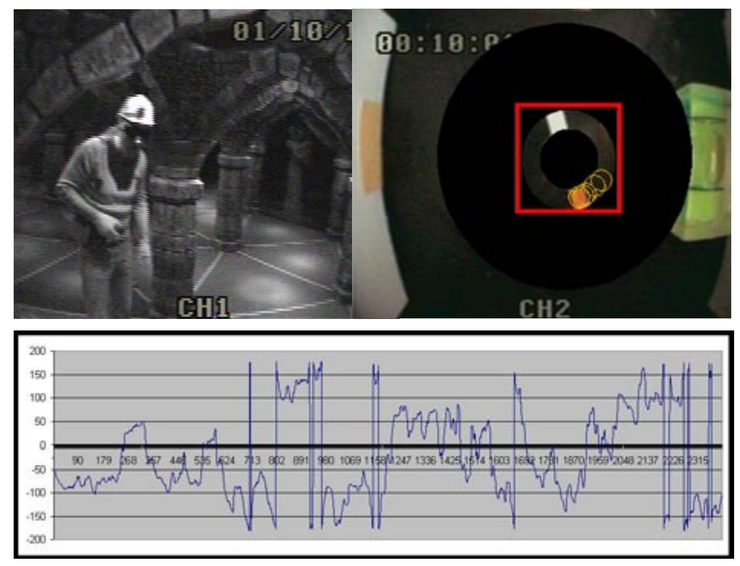

Figure 7: Automated recognition of orientation movements.

Data analysis: Preliminary results

Detailed results are not yet available at this point.
Currently, movement and orientation data are analysed and proper scales and means of visualizing the data are explored (fig. 7).

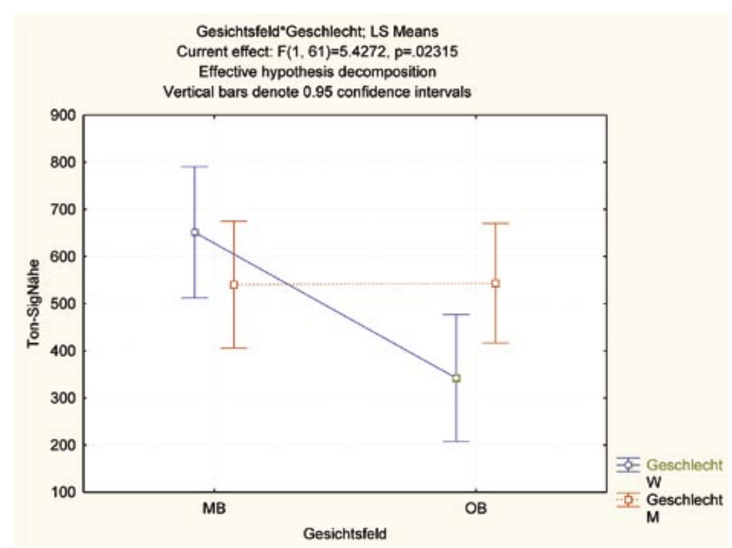

Figure 8: interaction effect between experimental condition and sex.