USER REPORT

Human Spatial Orientation and Way-finding Analysis with EthoVision in a Real Arena Maze

Tamás Makány and János Kállai
Spatial Orientation and Psychopathology Research Lab, Pécs, Hungary
Web: http://spacelab.btk.pte.hu
E-mail: max@mailbox.hu

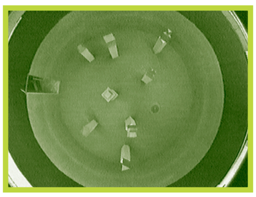
Adaptation of the Morris water maze for human subjects

Spatial orientation and way-finding performance of animals have already been objectively and extensively investigated with water maze tasks (introduced first by Morris in 1981 [4]). More recently, virtual adaptations of water maze tasks have been used to investigate human spatial cognition and navigation [1,2,3, 5]. Despite the innovative technology of virtual reality, the actual maze experiment cannot always be replaced and we needed to create a human adaptation of the original Morris maze in our laboratory.

Experimental setup

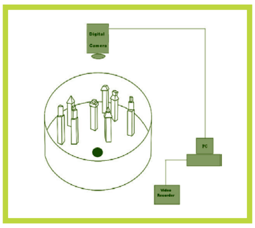
The main features of our set up were the circular arena (Ø 6.5 m); an invisible platform disc on the floor (Ø 50 cm) with pressure-sensitive detectors that elicit an electrically generated voice of 60 dB when the subject steps on it and eight navigation objects or landmarks (different fixed geometric cues) on 1 meter high pillars.

A video image of the arena maze was recorded with a digital camera equipped with a "fish-eye" lens to cover the whole arena. It was located 3.25 m above the exact center of the arena and was connected directly to a PC with EthoVision Color-Pro 3.0.



Camera view of the Real Arena Maze with the different geometric landmarks and the pressure sensitive platform disc on the floor.

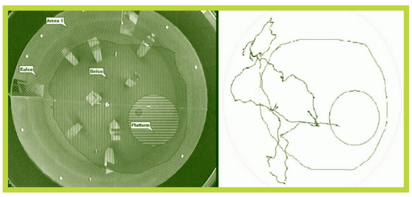
Constant lighting and colors were crucial points for the acquisition process. Therefore, during the experiment all windows were shaded and we used neon-tube lighting covered with a translucent white cloth to have diffuse illumination in the whole arena. The detection method was set to color tracking, hence colors of the floor and the objects had to be carefully selected. To reduce disturbances from reflections, we used subdued paint colors.



Layout of the Real Arena Maze.

Method

We tested 58 students. The subjects' aim in each of the 7 trials was to find the platform disc on the floor that elicited a voice when stepped on. They were wearing blinding goggles so no visual cues were available. As a result they had to depend on merely haptic information acquired by touching the fixed, geometric navigational objects. A red ball mounted on their heads with a headband made it easier to track them. EthoVision was set to find and follow this red colored object. This way, computing errors that would have resulted from tracing the whole human body (which has a much bigger surface area than a ball) were reduced.



Visualization in EthoVision: defined arena and zones on the left, the platform finding-route of a subject's trial on the right.

The plane of the acquisition was not on the floor, but at the level of the average height of the subjects added to the red tracking cue-ball's size. This was needed for the distortion-correction due to the height of humans as the arena layout had originally been based on the bottom of the arena, i.e. at floor level.

We used EthoVision's Advanced Calibration functionality, with 14 predefined positions inside the arena, but located 185 cm above the floor level. This also allowed us to eliminate the fish-eye distortion caused by the camera lens.

Results and conclusion

Spatial orientation and way-finding performance such as platform finding time, route length, speed and orientation strategies based on the time spent in certain zones were obtained automatically from the locomotion of the subjects while completing a complex spatial orientation task.

The presented method – which is based upon the Morris water maze protocol – is appropriate for reliable analyses of human spatial locomotion and actions. We are applying this system to various neuro-cognitive research projects including for instance investigation of gender differences, brain injured patients' and young children's spatial behavior.

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