# The Effect of Visuo-spatial Ability on the Selection of Route-Learning Strategies within Virtual Environments

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## Introduction

Siegel and White (1975) posit four, necessary stages in the development of the mental representation of a novel environment, starting with landmark identification, and culminating in the building of survey knowledge. However, recent studies suggest that there may be various different route-learning strategies, and that individual cognitive ability may determine the strategy employed. Studies investigating sex differences suggest that females adopt a landmark strategy whereas males prefer a geometric-based strategy (e.g. Holding & Holding, 1989). This is thought to reflect well-documented gender differences in visuo-spatial ability (Kimura, 1992).

To determine the influence of individuals' cognitive skills upon the route-learning process, subjects were pre-tested for visuo-spatial ability, and then asked to navigate through a computer simulated maze. If different learning strategies are indeed used and also dependant upon an individual's cognitive strengths, it is predicted that a participant with high visuo-spatial ability will adopt a geometric-based strategy regardless of the presence of landmarks. Therefore, even when landmarks are present, participants' visuo-spatial ability should correlate with a measure of maze completion time (CT) such that those with high ability complete the maze more quickly.

## Method

31 Edinburgh University undergraduates (16 female, 15 male) aimed to find the exit in a computer simulated maze. Participants' CT was measured on each of five successive trials, in a virtual environment where landmarks were either present or not present. As a pre-test measure of spatial ability, a form of Cooper's 2-Dimensional mental rotation task was used, where participants judge whether two presented shapes (one of which is rotated) are the same or mirror-images (Cooper, 1975). Maze CT was then correlated with the participant's mean response time for images presented at 180 degrees in the cognitive pre-test; this was found to be a difficult task and should therefore make considerable use of the participant's visuo-spatial ability.

## Results

It was found that for those adept at the visuo-spatial task, correlation between the cognitive test score and maze CT during the latter part of the learning process reached significance ($p<0.05$) in the non-landmark condition, and tended towards significance in the landmark condition. No significant correlation was found during the early phases of the learning process. Additionally, no significant correlation was identified for those subjects with poor visuo-spatial ability during any part of the learning process.

## Discussion

It was hypothesised that participants who were particularly proficient at visuo-spatial tasks would adopt a geometric-based learning strategy, regardless of the presence or absence of landmarks, and that this would be demonstrated by a significant positive correlation between their navigation and visuo-spatial task scores. For both landmark and non-landmark conditions, the correlation tended towards significance during the later sessions within the virtual environment. If the visuo-spatially 'talented' adopted a geometric strategy it would be expected that the correlation would be stronger during the early part of the learning phase, during which time they would be busy identifying the environment's geometric properties. The correlation demonstrated in this paper, between visuo-spatial skills and navigation task performance during the *later* stages of the spatial orientation process, fits more comfortably with the Siegel and White model, where the agent's spatial ability is thought to aid the development of survey knowledge in the later stages of the learning curve.

## References

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