Cognitive strategies in impossible worlds

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Abstract. When humans explore novel environments, they encounter physical landmarks and learn routes, gradually building a mental representation of the environment as a whole. This works very effectively in real-world settings, supporting navigation activities such as path planning and shortcuts. but details of the mental representations stored in the "cognitive map" are unclear and have been a topic of debate for many authors. One possibility is a Euclidean image-like representation in which a stored "snapshot" is analogous to the structure of the physical world. Alternately, the representation may simply involve ordered lists or sets of landmarks, though this would scale poorly to large environments. Finally, in the middle, a graph-based representation may allow for a conceptual ordering of landmarks without completely accurate Euclidean information.

Using virtual reality, researchers can manipulate sensory stimuli and even create virtual environments that do not conform to the same set of rules that are present in the real world. In past experiments, an impossible worlds paradigm was used in which participants explored virtual environments that violated real-world constraints. In these studies, after exploring the impossible worlds, participants were able to find shortest paths to landmarks even though they did not usually report noticing anything out of the ordinary. This ability to successfully create a model of a non-Euclidean world and use it to make accurate distance judgments, while remaining unaware of the violation of real-world constraints, provides evidence against the existence of image-like mental representations. However, if not image-like, then there are still questions about the format of the actual representation.

Using the impossible worlds paradigm described above together with a traditional dual-task selective-interference paradigm, a new study examines the cognitive strategies employed while learning environments that violate real-world constraints. In the study, participants are asked to remember spatial or verbal memory sequences while learning virtual environments. These concurrent memory tasks are intended to interfere with a participant's ability to build a mental representation of the environment if both require common resources. Understanding the cognitive resource demands during map learning will provide additional information about the nature of the constructed representation. Additionally, it is possible that participants may revert to alternate cognitive strategies when an image-like mental representation is not reliable. If this is the case, results should show different cognitive resource demands when the environment is impossible as compared to when it is possible.