

The Role of Cognitive Maps in Familiarity and Wayfinding

Cristina Robles Bahm^{1,6}, Trishia Domingo^{2,6}, Aderinsola Falana^{1,6}, Nekia Hampton^{3,6}, Maryam Hedayati^{4,6}, Ruth Maurat^{5,6}

¹University of Pittsburgh

²University of Maryland Baltimore County

³University of Baltimore

⁴Carleton College

⁵Florida International University

⁶iSchool Inclusion Institute (i3)

Abstract

Wayfinding is a difficult task that can be broken down into the interaction of a user with spatial information. It has been found that participants that are familiar with an environment are more successful at wayfinding than those that are not. It has also been found that participants that are familiar with an environment give wayfinding descriptions differently. This poster begins to examine familiarity in terms of the concept of the cognitive map. By exploring the formation of a cognitive map over time we can begin to examine the relationship between the cognitive map, familiarity with an environment, and wayfinding success. This poster outlines an experimental design for future work that examines these three areas together.

Keywords: Wayfinding; spatial information; human factors; human information processing

doi: 10.9776/16462

Copyright: Copyright is held by the authors.

Acknowledgements: Thank you to Mike Depew and the iSchool Inclusion Institute

Contact: cmr93@pitt.edu

1 Introduction

At its core wayfinding is an act of spatial information processing. Finding one's way around the world is a complex task. It involves several cognitive processes such as problem solving, perception, and attention. How well a human being is able to process the spatial information they encounter during wayfinding determines their success. The purpose of this poster is to present an experiment design that examines the relationship between the wayfinder, their cognitive of an external environment, and their familiarity with that environment. The contribution of this poster is to begin a dialogue and propose an experimental design that begins to answer the questions:

- What is the role of cognitive map formation in becoming familiar with an environment?
- Does that familiarity change the way human beings interact with spatial information in terms of wayfinding over time?

2 Background

It is no secret that a user who is familiar with an environment will be able to process the spatial information in that environment easier than a user that has no familiarity. This ability to process spatial information better leads to more successful wayfinding. But what exactly is familiarity? If one is able to familiarize oneself with an environment quicker that should make wayfinding easier. In order to begin to answer these questions we look at familiarity in terms of cognitive map formation.

2.1 Cognitive Map Formation

First introduced as the Cognitive Map by Tolman in 1948 the cognitive map is a concept that explains how human beings organize their environment in terms of what is in the environment and their relationships to each other. In his seminal work Tolman also outlined that the way one acquires a cognitive map is by interacting with, and exploring, an external environment. It has been proven that a cognitive map is not necessarily an accurate representation of an environment, but instead is a representation of how the environment is represented to the person who possesses the cognitive map (Nadel, 2013). A user's cognitive map, has also been cited as one of the reasons why people get lost in buildings (Carlson, Holscher, Shipley, & Dalton, 2010). All of these pieces of information taken together

begin to outline the importance of the cognitive map in wayfinding. Being able to build a relationship internally of the parts of an environment is critical when successfully getting from point A to point B. By examining a participant's cognitive map we can get an idea of how robust their internal representation of an environment is.

2.2 Familiarity in Wayfinding

Lovelace, Hegarty, & Montello (1999) found that participants give different wayfinding descriptions when they were familiar with an environment. It has also been found several times that familiarity with a location will lead to faster and more accurate wayfinding, even if unfamiliar participants take the same route (Hölscher, Meilinger, Vrachliotis, Brösamle & Knauff, 2006). Familiarity with a building can also lead to fewer problems in navigating the building (Li & Klippel, 2012). That being said, familiarity with a location is very important to successful navigation. It has been found that being familiar with a location allows participants to take detours (Spiers & Maguire, 2008). This point is important because it begins to give us insight into the relationship between the cognitive map and familiarity. Presumably familiarity with an environment leads to better wayfinding because a participant who is familiar with an environment also has a robust cognitive map formed of the environment.

3 Challenges in Familiarity and Spatial Information Processing Research

There are several challenges to this type of research. In this poster we focus on the challenges of using cognitive concepts to examine familiarity.

3.1 Using Cognitive Concepts to Examine Familiarity

The main question this poster begins to ask is if we can use a participant's cognitive map to promote familiarity with an environment and thus lead to better wayfinding. In other words, does building up a cognitive map automatically make the participant more familiar with the environment? And does this lead to better wayfinding? One of the main challenges in asking these questions is that of evaluation. There are several methods that would allow us to determine a participant's formed cognitive map (Lohmann, 2011; Passini, 1981; Passini, 1984), but how would we use this in terms of familiarity? Especially since it has been determined that a cognitive map is not an accurate representation of an external environment (Nadel, 2013).

Cognitive maps are formed over time (Tolman, 1948) as a participant explores an external environment. Because of this, the project we outline in this poster would need to be one that is run over time. Allowing cognitive maps to form naturally in a group of participants would be the best measure of cognitive maps and familiarity.

4 Proposed Future Work

In order to examine the question of cognitive map formation, familiarity with an environment, and wayfinding success we propose a study that examines the question from three points of view:

- Familiarity with an environment over time: The purpose of this is to gauge how familiar participants become with the environment over time.
- Cognitive map formation over time: The purpose of this is to see how their cognitive maps form and change over time.
- Ability to provide wayfinding descriptions over time: The purpose of this is to see how their ability to give wayfinding descriptions changes over time.

All three of these points are expected to change as a participant becomes more familiar with an environment. By looking at all three the relationship between cognitive maps, familiarity, and interaction with spatial information will be able to be explored further.

4.1 Experimental Design

To elicit and evaluate the cognitive maps formed by participants, both linguistic and graphical modeling methods will be employed. It is important to evaluate the formation of cognitive maps both from a linguistic as well as a graphical point of view because often the way we interact with spatial information is easily described, but not easily modeled graphically and vice versa. Linguistic methods will follow the protocol set forth by Landau & Jackendoff (1993), while graphical modeling methods will follow Appleyard (1970). These methods will allow us to accurately model and evaluate the cognitive maps formed by participants at various points in the study. In examining the cognitive maps formed at various points in

time we will be able to get an idea of how these maps are changing as participants engage with and become more familiar with their environment.

We propose using undergraduate students at the University of Pittsburgh as a subject population. We suggest conducting an extensive user study that begins when the students are freshman at the university and ends when they are seniors, or are about to graduate. Students will check in every six months to participate in the study. This will begin to give insight into the formation of a cognitive over time, presumably as users become familiar with an environment. At each check in participants will be asked to give wayfinding descriptions from various landmarks to other landmarks in both verbal and graphical form. This will allow us to evaluate the formation of their cognitive maps over time.

Participants will also be evaluated in terms of their general sense of direction and knowledge of landmarks on the campus. Together with the linguistic and graphical modeling methods we believe these data will allow us to begin the study of familiarity and cognitive map formation.

5 Conclusion

In conclusion, wayfinding is a difficult task. However, it has been found that participants that are familiar with an environment are more successful at wayfinding than those that are not (Carlson, Hölscher, Shipley, & Dalton, 2010; Hölscher, Meilinger, Vrachliotis, Brösamle & Knauff, 2006; Li & Klippel, 2012; Spiers & Maguire, 2008). It has also been found that participants that are familiar with an environment give wayfinding descriptions differently (Lovell, Hegarty, & Montello, 1999). This poster begins to look at this relationship in terms of a cognitive concept: the cognitive map. By exploring the formation of a cognitive map over time we can begin to examine the relationship between a cognitive map, familiarity with an environment, and wayfinding success.

This poster outlines an experimental design that relates the three concepts of a cognitive map, familiarity, and wayfinding over time. The proposed study is run over time and allows the cognitive map of participants who are at first unfamiliar with an environment to form over time.

6 References

- Appleyard, D. A. (1970). Styles and methods of structuring a city. *Environment and behavior*, 2, 100-116.
- Carlson, L. A., Hölscher, C., Shipley, T. F., & Dalton, R. C. (2010). Getting lost in buildings. *Current Directions in Psychological Science*, 19(5), 284-289.
- Hölscher, C., Meilinger, T., Vrachliotis, G., Brösamle, M., & Knauff, M. (2006). Up the down staircase: Wayfinding strategies in multi-level buildings. *Journal of Environmental Psychology*, 26(4), 284-299.
- Landau, B., & Jackendoff, R. (1993). Whence and whither in spatial language and spatial cognition? *Behavioral and brain sciences*, 16(02), 255-265.
- Li, H., & Giudice, N. A. (2012). Using Mobile 3D Visualization Techniques to Facilitate Multi-level Cognitive Map Development of Complex Indoor Spaces. *Spatial Knowledge Acquisition with Limited Information Displays*, 21, 31-36.
- Li, R., & Klippel, A. (2012). Wayfinding in libraries: Can problems be predicted?. *Journal of Map & Geography Libraries*, 8(1), 21-38. Chicago
- Lohmann, K. (2011). The use of sketch maps as a basis for measures of spatial knowledge. Paper presented at the Understanding and Processing Sketch Maps. In: Proceedings of the COSIT 2011 workshop. AKA Verlag, Heidelberg.
- Lovell, K. L., Hegarty, M., & Montello, D. R. (1999). Elements of good route directions in familiar and unfamiliar environments. In *Spatial information theory. Cognitive and computational foundations of geographic information science* (pp. 65-82). Springer Berlin Heidelberg.
- Nadel, L. E. (2013). Cognitive Maps. In Waller, D. E. & Nadel, L. E. (Eds.), *Handbook of spatial cognition* (155-171). American Psychological Association.
- Passini, R. (1981). Wayfinding: A conceptual framework. *Urban Ecology*, 5(1), 17-31.
- Passini, R. (1984). Spatial representations, a wayfinding perspective. *Journal of environmental psychology*, 4(2), 153-164.
- Spiers, H. J., & Maguire, E. A. (2008). The dynamic nature of cognition during wayfinding. *Journal of environmental psychology*, 28(3), 232-249.
- Tolman, E. C. (1948). Cognitive maps in rats and men. *Psychological review*, 55(4), 189.