Towards the Creation of Cognitively Salient Wayfinding Aids for Emergency First Responders

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Abstract. This work presents a literature review on the creation of cognitively salient wayfinding aids for emergency first responders. The importance of the topic as well as the contributing areas are discussed. Areas include indoor navigation, cognitive aspects of wayfinding, and mental representations of space. A study focused on determining the interactions of first responders versus civilians with spatial information is proposed to help fill the gaps in the literature.

Keywords: Wayfinding, Emergency Responders, Indoor Navigation.

1 Introduction

An emergency first responder is defined as any person who is trained to help as one of the first people to arrive at the site of an emergency or natural disaster. By the nature of their work, emergency first responders are often required to navigate unfamiliar places with limited time to acquaint themselves with a space. This situation calls for tools that allow familiarization with spatial information quickly and with little cognitive overhead. Given the high-risk nature of their work and the many ways in which technology could aid them, further exploration of this area is not only relevant but imperative. By gaining a better understanding of how emergency first responders use and interpret the spatial information in their tools, the development of wayfinding aids can be made better by focusing on its cognitive salience or an understanding of the most important or prominent concepts through experience and application.

2 Background

To begin, we review literature in indoor navigation and cognitive aspects of wayfinding in the context of emergency first responders specifically. This dual approach allows us

to comprehensively view the problems emergency responders face when engaging with wayfinding aids in emergency situations.

2.1 Indoor Navigation Complications of Indoor Navigation

In indoor spaces, standard navigation principles are complicated by a variety of factors [4]. One such factor is the issue that landmarks, which are a universal component of human navigation, are not easily recognizable indoors. They often take the form of more commonplace things such as doors or stairwells [9, 7]. This absence of a universal navigation cue means that it is nearly impossible for a wayfinding tool to differentiate the display of spatial information for a door that is a landmark and a door that is just a door. Specific to emergency responders, existing studies primarily shed light on how pedestrians can find the shortest path to an exit or safety, but they fail to assess how first responders can use similar methods [10]. Given that emergency first responders have limited time to do their jobs safely, the tools they use for navigation must allow them to quickly move in an unfamiliar indoor space. They also must be familiar enough with the space to not be forced to rely upon a pre-planned route, since blockages or collapses can render certain routes unusable [13].

In addition to indoor navigation in general, first responders often operate in low-visibility situations. One possible difficulty in generating reliable navigational tools for them is the challenge of giving directions that are still comprehensible when they cannot be seen. One possible solution to this is the use of auditory cues, which have been found to make blind exploration of a space nearly as effective as sighted exploration of the same space [3]. Another possibility is finding a way to mobilize illuminated tools. Devices such as exit signs are illuminated specifically so they can be seen and provide direction in low-visibility areas; if similar illuminated technology could be applied to a first responder context, some of the struggles associated with poor visibility could be alleviated [8].

2.2 Cognitive Aspects in Wayfinding

Mental Mapping and Spatial Learning: Emergency first responders must be able to quickly create a mental map of an indoor space given the spatial information they encounter. For spatial recognition and learning, using landmarks is typically considered more efficient than focusing on distances, as landmarks are easier to follow [12]. However, as outlined above, indoor spaces are often devoid of landmarks. A direction such as “turn left at the flagpole” is easier to comprehend than “turn left in 500 meters,” where the distance must be gauged by the user. But how is this finding reconciled in emergency first responder situations where landmarks are likely not possible navigation cues?

Representation of Directions and Spaces: How spatial information is displayed to emergency first responders is an important aspect to explore, but is still understudied. In building a navigation tool for emergency first responders, symbolic indication of different conditions is critical; however, current research indicates that a majority of commonly used crisis map symbols are misinterpreted, sometimes critically so [1].

Since first responders have very limited time to absorb spatial information for the buildings they are navigating, the models they learn from must be easy to evaluate and the ability to make a decision using them is critical. In terms of visualizing spatial information, a 3D model is more realistic than a 2D one. Although work has been done on how to develop a 3D model, future research on such models like "safety-critical simulations" may prove to be beneficial for the emergency first responder community and could be a relevant area of investigation.

Personalization: Maps are more useful when they are personalized to the task they are being used for. Central to design of navigation applications is the interaction between the user, the device, the environment, and the task being performed [5]. Research is being done on how to integrate information from clicks and searches to personalize maps and to suggest where a user may want to go [2]. However, there is a gap in the research when it comes to personalizing tools for emergency first responders; though their mode of operation is very different from that of the general public, there is not a customization yet that adequately addresses the firefighters' indoor navigational needs.

3 Proposed Research

The proposed study will illuminate the information needs of emergency first responders when navigating indoor environments taking into account the areas of the literature outlined above. An examination will be conducted of how two different groups of people (first responders 18+ and non-first responders 18+) navigate, with limited time, through an indoor facility. Specifically, we want to compare the perspectives of firefighters and non-firefighters when navigating through an indoor facility to help identify the most cognitively salient way to navigate and map an indoor facility. Part 1 focuses on analyzing technologies and methods currently in use by firefighters and non-firefighters in terms of their cognitive salience and spatial information representation. Part 2 focuses on how the most salient parts of those technologies and methods can be integrated into new wayfinding technologies and methodologies. The purpose of this research is to inform and improve on future research and applications designed for first responders and their experiences with indoor navigation. With a better understanding on the perspectives of firefighters and non-firefighters a more cognitively salient wayfinding aid can be created specifically for them.

3.1 Experimental Design

This study aims to gather information on how well participants can learn how to navigate through an unfamiliar indoor space. Participants will be asked questions at the beginning of the interview that relate to factors that may affect their ability to create a mental map in a short period of time. No audio component will be available in the standardized video. Although prior research has shown that the efficacy of auditory cues on the creation of cognitive maps is comparable to that of visual cues [3], audio has been omitted from the video in order to remove confounding variables from the

research design. Participants will watch a standardized video walkthrough of an indoor space and they will be examined on their ability to remember the layout space and to navigate the space on their own. Time to rescue as well as how many minutes spent lost would be the metrics by which success would be determined in this part of the study. Putting the results of the landmark and the representation studies together would allow the scientific community to move towards a wayfinding aid that has a cognitive display. Participants will be interviewed in two categories, which will be first responders and non-first responders (civilians). Furthermore, a prototype would be developed that displayed the spatial information pertaining to the landmarks and other information in several representations as outlined in the literature above.

4 Conclusion

In conclusion, current implementations on indoor wayfinding technologies or methods could significantly increase both the efficacy and the safety of emergency first responders. By examining cognitive salience in terms of landmarks and representations of space, we explore the current literature on indoor wayfinding and emergency first responders, in addition to proposing an experiment that would help fill a major gap in that literature.

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