A study on visual and structural characteristics of landmarks and experts' and non-experts' evaluations

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Abstract. The aim of this study is to understand what makes a landmark more salient and explore if the assessments vary between experts and non-experts. We hypothesize that non-experts' saliency judgments will be in conformity with those of experts. Secondly, we argue that not only visual characteristics but also structural characteristics make landmarks salient and size and visibility of objects are important for them to be considered as salient. To test our hypotheses, an online navigation game, Sea Hero Quest (SHQ), was used and two levels of the game were selected as the case study. The characteristics of these levels were evaluated by experts in the field and by non-experts. Our results suggest that both visual and structural characteristics of landmarks make them more salient. We also discovered that experts' saliency evaluations are mostly consistent with non-experts'.

Keywords: Landmarks, Saliency, Navigation, Wayfinding.

1 Introduction

Landmarks, as components of environments, play an important role in wayfinding tasks. They can be used in wayfinding tasks to identify specific points [1], understand whether or not the followed path is correct [2, 3], organize spatial knowledge [4], change the position along a route [2], or learn a new route [5]. Therefore, they help people to find their way in different aspects. However, it is still not completely clear what makes a landmark unique to be preferred by more people for route definitions or orientation, or for any other wayfinding-related purpose. This study aims to better understand the characteristics of landmarks that make them salient or less salient. Moreover, we aim to understand if the salient landmark definition varies between experts, who are working on wayfinding-related studies, and people (non-experts), which is quite limited in the literature.

2 Background

The characteristics of landmark that make them preferred by more people were analyzed and research focus on visual, structural and cognitive characteristics of objects [6]. Visual landmarks are distinguished based on their physical characteristics such as color, size or shape. Cognitive landmarks are more personal; they have a cultural or historical meaning. Hence, even if an object does not have any visual attractiveness it can still be used by an observer to way-find. A structural landmark is about the location of objects in an environment. This definition was then improved by Caduff and Timpf as the authors stated that methods should be suggested to measure saliency quantitatively [7]. Authors introduced three terms of saliency: perceptual, cognitive and contextual. Similar to Sorrow and Hirtle, they identified the physical characteristics of objects for describing perceptual salience. They extended the definition by describing three categories of perceptual salience: location-based (colour, intensity, texture orientation), scene-context (topology and metric refinements) and object-based (size, shape and object orientation). Two components were identified for cognitive salience: the degree of recognition (indicating how well objects can be identified from others) and idiosyncratic relevance (the personal importance of objects for observers). For contextual saliency, researchers focused on two types of contexts: task-based context, which includes the types of tasks, and modality-based context, which includes the mode of transportation and the number of resources. By using these terms, studies aimed to explain the most effective saliency criteria for wayfinding. Results showed that structural salience [8, 9], visibility (the ability to see a landmark) [8, 10] or color [10] could be effective during a wayfinding task.

On the other hand, a limited number of studies focused on the combined impact [2, 11]. Albrecht and Von Stülpnagel aimed to explore the combined effect of visual and structural salience on wayfinding. They located visually salient objects both at structurally salient locations and structurally less salient locations. Researchers discovered that people tended to remember a turn correctly if a visually salient landmark is located in the turning direction. Similarly, Michon and Denis [2] asked twenty people to learn two routes by navigation and to generate route directions. Researchers observed that visual landmarks are better remembered when they are close to nodes. Thus, both studies pointed to the idea that visually salient landmarks are preferred more when they are at structurally salient locations. Still, there are not a sufficient number of papers about the combined characteristics of landmarks. This study is therefore unusual in considering the combined effect of two criteria. Moreover, the number of studies on experts' and non-experts' evaluations on landmarks is quite limited. An interesting study was done by Cheng to analyze landmarks by experts' and non-experts' perceptions [12]. Two groups were used for this study: expert group was defined with the landscape architects who lived and worked in the study area for over ten years and non-expert group was defined with local residents who lived in the study area for again more than ten years. Both groups answered questions about landmarks and the results of the study showed that singularity (sharp visual contrast with the background) and spatial prominence (location of landmark- they are visible from many points) were effective on participants' identification of landmarks. In addition, results

of the study showed similarity and differences between two groups. This is the only study authors could find, which compared the saliency evaluation of experts and non-experts. Hence, in this study, we use the combined effect of visual and structural characteristics of landmarks and experts' and non-experts' saliency evaluations.

3 Method

An online game, Sea Hero Quest (SHQ), was selected as a case study [13]. The game was released in 2016 and more than 4.3 million people downloaded and played it. Seventy-five levels (and environments) were designed for the game. In wayfinding levels, which are used in this study, participants were first asked to view a map where they could see the start point of the wayfinding task, the environment that they would move in and the locations of the numbered buoys that they should find. Then they closed the map and started navigating a boat in a river/canal environment and finding the buoys. Not only the environments but also weather, map and landmark conditions varied in levels. Accordingly, the weather was clear (so that people could see their surroundings easily) or foggy (so that people could only see their immediate surroundings clearly) or the canal was wavy (so that visibility changes constantly). Map condition was either clear (so the layout and the checkpoints could be seen clearly) or obscured (the layout couldn't be seen clearly, only the checkpoints could be viewed). Saliency of landmarks also varied as "none" (no landmarks), "hard" and "easy landmarks". Salient (easy) landmarks in the game are defined with visually salient objects [6] that are located at accessible points, and less salient (hard) objects referred to salient objects located at segregated points, as rated by experts in the field.

We used two levels of SHQ, where: 1) the layout of levels are as similar as possible (we used Space syntax axial and segment based analysis as well as complexity measures to define similar layouts 2) the conditions are the same, while 3) saliency of landmarks vary as salient and less salient (**Fig. 1**). Space syntax measures included axial and segment based integration and choice (r: n, 3), axial based intelligibility, VGA (visual connectivity, visual integration, intelligibility), and connectivity (directional reach based on 10° for 0 and 2 direction changes, metric reach for 10 meters and 100 meters), whereas measures included number of decision points and destinations, total segment length, shortest route. Clustering was conducted by using these measures and similar layouts were selected [14]). Levels 31 and 32 are selected because the levels included same landmarks (there were only two additional landmarks in level 31) that are located in very different positions (structural saliency). Level 31 had easy landmark condition and level 32 had hard landmark condition.

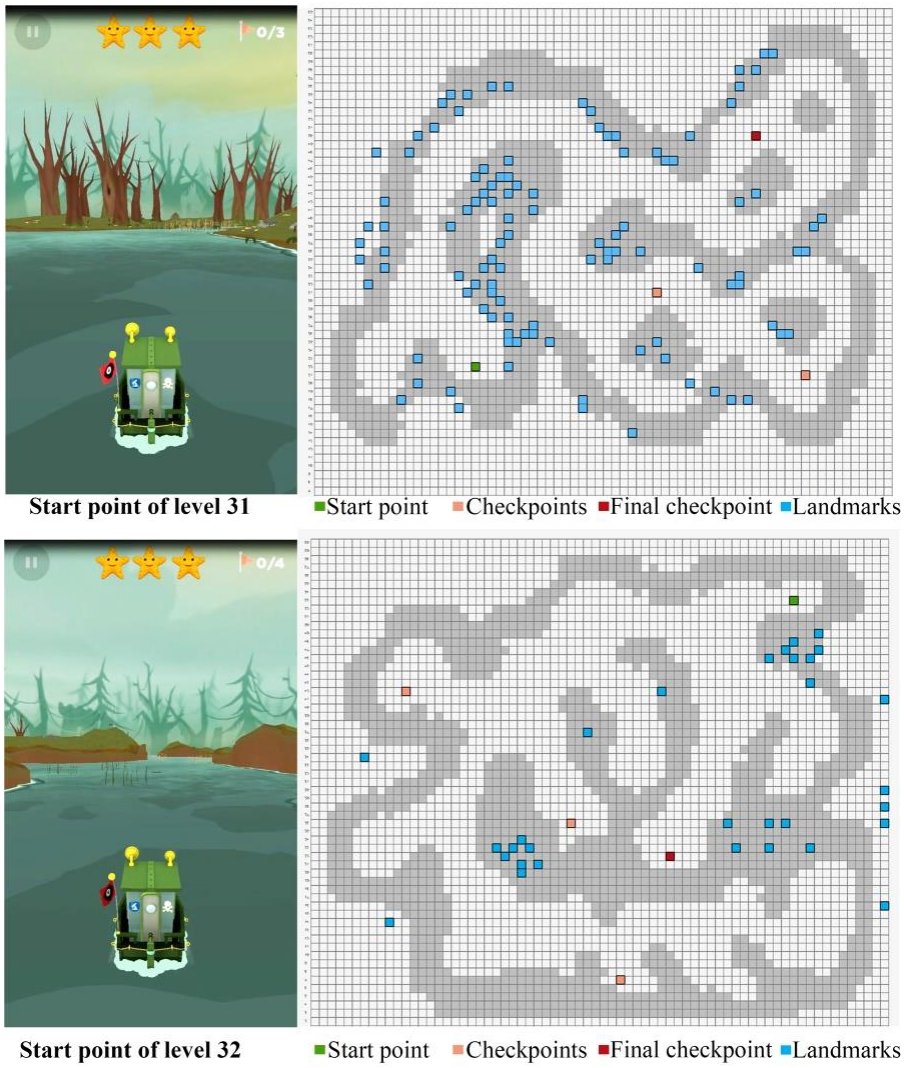


Fig. 1. Layout of levels 31 and 32 and position of landmarks: screenshots were taken from the start points of level 31 (above) and 32 (below) and the start points, checkpoints, and final checkpoints were shown on the maps

3.1 Survey Design

Once the levels are selected, a video was recorded for each level where the boat moves and finds all buoys in turn. Then the screenshots were taken from the video (from approximately same distance) for each landmark to show the participants. Two images were created for each landmark; in one, participants could see the image of a

landmark as the way they see it in the video, and a transparent image where they can focus on the landmark that they are asked to evaluate (**Fig. 2**).

The web-based survey (Google survey) was prepared and participants were recruited online via a range of social media channels (from March 22nd to April 5th 2019). The consent form was approved by Northumbria University Ethics Committee. 251 people aged between 18 and 70 attended to the survey (f=165, m=84, o=2). In the beginning of the survey, participants were asked to answer questions about data protection and participation as well as demographic questions. Then they were asked to watch the videos respectively and pay attention to the environment through which the boat would move. They were warned to watch the videos before they move to the next section. When they finished watching the videos, they saw the images of landmarks in a randomized order and they were asked to categorize landmarks using a 5-point Likert scale from 1 (unnoticeable) to 5 (highly noticeable).

Fig. 2. Images of landmarks that are shown to participants (on left, background is transparent so that the landmark can be clearly seen and on right, the scene is directly taken from the video).

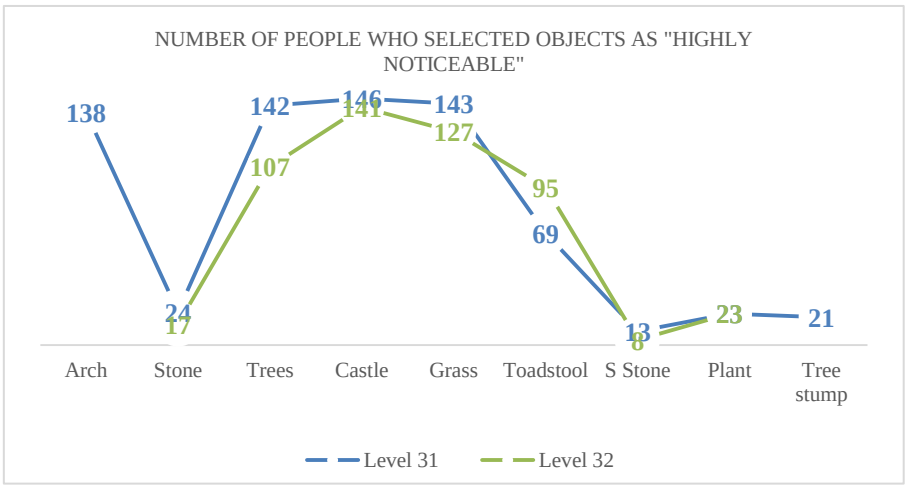
For each landmark, we already had an equalized rating provided by the experts (N=4). Experts in navigation studies were selected from different disciplines (architecture, psychology, cognitive science) and different universities. They considered visual saliency of landmarks as the context of the game was developed with their definitions (so they saw landmarks individually with a white background, rather than seeing them in the environment).

4 Results

Results of the survey study showed that size and color of objects are important for them to be chosen as salient objects (see **Table 1**, and **Fig. 3**). Castle, grass and trees were selected as salient objects in both levels. This was followed by arch and toad-

stool in level 31 and by toadstool in level 32. Small stone and plant were rated by a limited number of people as highly noticeable.

Table 1. "Highly noticeable" objects for levels 31 and 32 for non-experts' (there was no tree stump or arch in level 32)



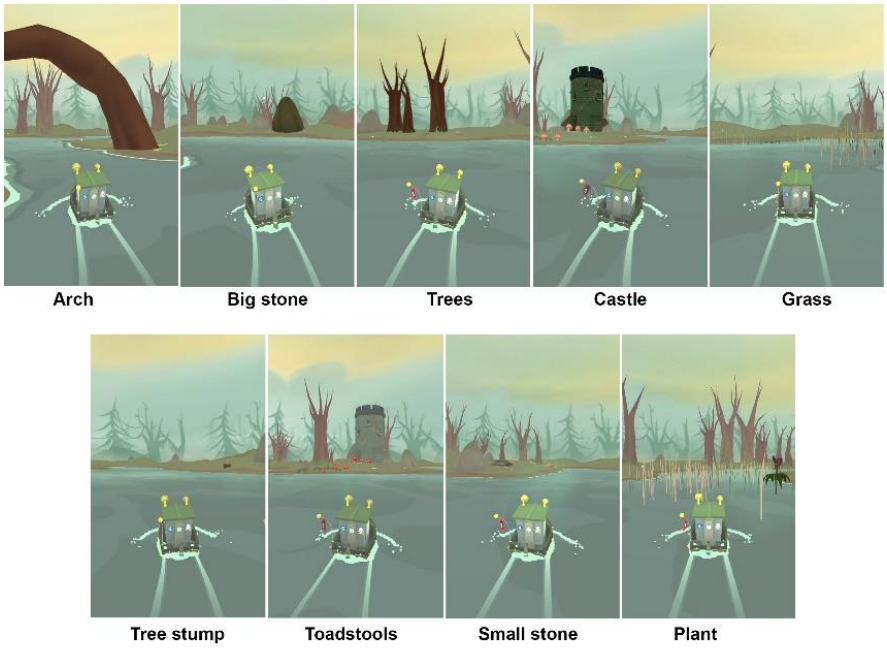


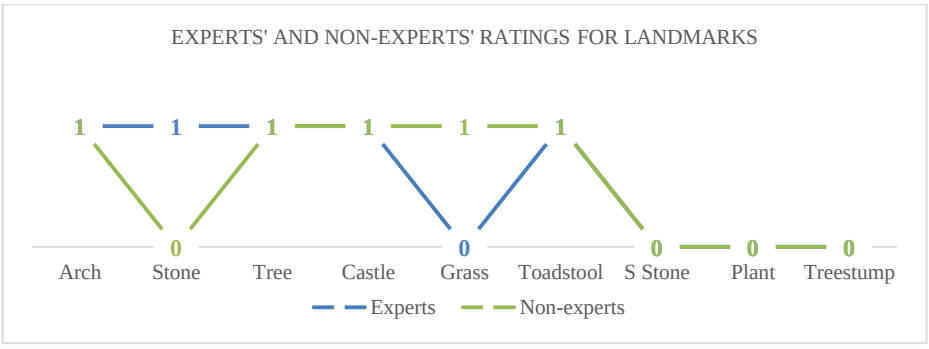
Fig. 3 All landmarks that are shown to participants; images are taken from level 31 (all shown with a transparent background)

More importantly, the table shows that the number of objects that are rated as "highly noticeable" is higher in level 31 compared to level 32 (except for toadstool). When the videos are played again, it was seen that the boat moved quite close to the toadstools in level 32 (**Fig. 4**). Hence, participants could have a chance to see this landmark closer, which can account for this change. In addition, in level 31 mentioned toadstools were seen with many other landmarks, while in level 32 they were seen alone. This can support the findings of previous studies [15, 16], where people mentioned that the existence of salient landmarks can make other landmarks less salient. For the other landmarks, however, we can claim the impact of structural saliency in rates.

Fig. 4. The image used in level 31 and 32 to evaluate the toadstool

In addition, we compared the experts' results with non-experts'. Experts' saliency evaluation included two categories: salient objects (1) and less salient objects (0). Hence, non-experts' evaluations were also categorized as salient and less salient objects. **Table 2** shows the results of two groups together.

Table 2. Results of experts' and non-experts' evaluations. "1" represents salient landmarks and "0" represents less salient landmarks.



Results suggest that the ratings are same for all landmarks, except for stone and grass. Stone was selected as a salient object by experts and grass was selected as a salient object by non-experts while they were selected as less salient landmarks by the other group.

5 Discussion

This study aimed to work on properties of landmarks, which make them salient. In order to better understand this issue, we focused on visual and structural characteristics of landmarks. An online game, SHQ was used for this purpose and objects that vary with their shape, size and color were used as well as their positions in the environment. Two levels of the game selected based on their spatial values (that they were similar) and their conditions (all conditions were the same except landmark condition). In one of the levels, level 31, landmark condition was defined as "easy" by the experts and in level 32, it was defined as "hard". Therefore, we used these two levels and asked participants to evaluate saliency of landmarks.

First of all, results of the study pointed to different objects as salient landmarks: the castle, trees, grass and arch were defined as the highly noticeable objects by a high number of participants. Even though some characteristics of objects differentiate, we can say that trees, castle and the arch were different from their surroundings with their height and color. Therefore, our findings indicated that color (and the contrast with the background) and size are significant visual characteristics of landmarks. These results were parallel with the finding of the previous research [10] . Moreover, parallel to the experts' thoughts, people thought objects in level 32 were less salient. Only toadstool was not coherent with this finding. When we see the videos again, we observed that unlike the other objects, in level 32 toadstools were closer to the screen (so they could be seen more easily). This result is very important because the landmarks were consistent between levels, and the location altered –visual saliency was same and structural saliency changed-. This implies that changing structural saliency can affect people's perception on visual saliency. This finding replicated the findings of the previous research [2, 11].

When we focus on structural saliency, on the other hand, it was observed that people's results were confirmative with experts'. The objects in level 32 (the level with low spatial integration, according to the experts) were rated by less number of people as highly significant, compared to level 31. Only one group of objects was evaluated differently out of nine, which were toadstools. When we focused on why, we saw the position of toadstools changed significantly in two levels: in level 31 they were away from the screen and with some other salient landmarks (castle, trees), which could be the cause for the lower number of rates. In addition, when we compare the two levels, in level 32 the number of landmarks decreased, no arch and tree stump was used and the location of landmarks is also changed (**Fig. 5**).

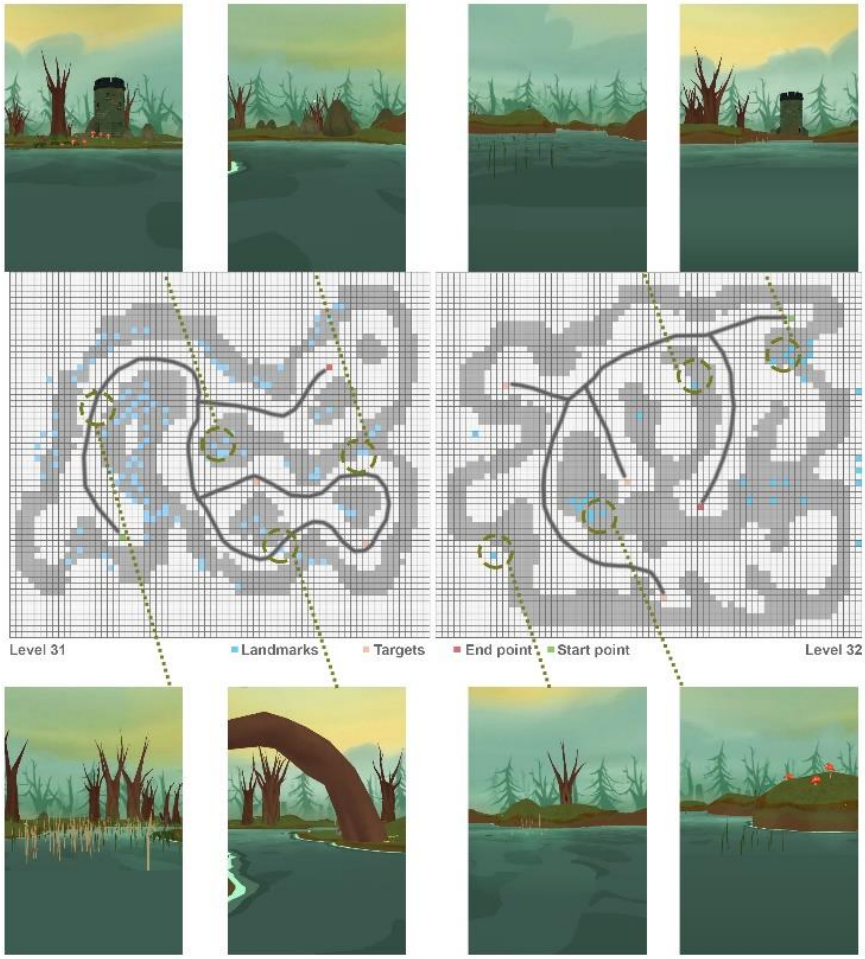


Fig. 5. Layout of two levels and the location of landmarks

As all can be important factors, when the two videos were watched again, it was better seen that the location of landmarks were significantly different in two levels. In one, level 31, objects were on route, visible from many angles and close to the observers (so that they could be seen from short distances, and also many times) while in the other level, level 32, trees, castle and stone (some of the salient landmarks of level 31) were away from the route and they were not seen many times or from too many angles. Hence, it can be said that the location of objects are also effective on an object to be defined as a salient one, as mentioned in the literature [9].

In addition, we discovered that the saliency descriptions of experts were effective on survey results, as we expected. In the literature, researchers could find similarities and differences between groups [12]. In this study, we found that expert's results could explain survey results for many landmarks; however there were differences for

two landmarks. The reason for the differentiation can be explained with the "context" based limitations [7]. While non-experts could view the landmarks in the game environment, experts view the landmarks without seeing the environments, just with a white background. Moreover, experts saw only images, while experts viewed a video, which also could cause a difference in their evaluation. Hence, this can be accepted as one of the limitations of the current study.

The sample size of landmarks was another limitation of this study (9 landmarks in level 31 and 7 in level 32). Moreover, we compared the results of 251 non-experts with 4 experts. More research can be done to explore the evaluations of the two groups and by working with a higher number of experts.

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