Learning of Visual Route Instructions for Indoor Wayfinding

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Abstract. Visitors of complex buildings might be presented with individual visual route instructions shown on ambient displays. Such route instructions can automatically be generated by a modelling software. It was investigated which route instruction format would foster human wayfinding most effectively in a naturalistic wayfinding scenario in a real building. Egocentric, view-based formats (animated virtual walk of the route, sequence of pictures of decision points) were compared to maps with route indication. In each of the three conditions, 16 participants were tested individually. Participants watched the route instruction passively and then walked the route through the real building. Critical wayfinding errors showed a clear advantage of the animated "virtual walk" instruction format. This advantage is explained by the accordance of the virtual walk with the real wayfinding experience. This includes the "analogous" transmission of turning information in the form of movements of the virtual camera.

Introduction

Learning Routes

Studies on environmental learning suggest that qualities of mental representations of the environment differ (Siegel & White, 1975), depending on the learning experience (e.g. Thorndyke & Hayes-Roth, 1982; Shelton & McNamara, 2004). Route knowledge is conceived as associative memory of an ordered sequence of landmarks and directions from egocentric views, such as experienced when navigating. Route knowledge might thus best be learned if a route is presented sequentially from the egocentric perspective.

Empirical studies on route learning in real environments, however, do not consistently support this idea. For instance, first-time visitors of a university campus, which were presented with route instructions at an information desk, preferred maps over a sequence of view-based photographs (Devlin & Bernstein, 1995). Passively viewing a route in a virtual environment did not transfer to wayfinding success in the real building, and virtual environmental training was not superior over studying a map (Farrell et al., 2003). Indoor wayfinding behavior might be affected by a number of factors, including the complexity of the architecture and individual strategies (Hölscher et al., 2006). The present study investigates what route instruction format is most effective for route learning in a complex building.

Wayfinding support in complex buildings

Visitors are presented with individual visual route instructions on ambient displays in the environment. The present approach is based on the modelling software Yamamoto (Stahl & Haupert, 2006). A model of a building includes outlines of rooms and corridors, height data, topology and definition of building levels and staircases, as well as semantic annotations (like ‘this edge represents a door that connects two rooms’). The resulting model represents all structural elements with their function for wayfinding. In conjunction with a routing algorithm, Yamamoto automatically visualizes any path inside the building from egocentric as well as from allocentric perspectives.

Empricial Study

Materials and Procedure

The new computer science building on Saarland University campus was chosen as the real environment for the present study. The building consists of separate functional areas with different structural features. Two partial routes were selected. The first partial route led through an open gallery system on the first floor to the library’s terrace on the second floor, and the second partial route led from the library to a particular meeting room on the third floor, which comprised a corridor with side-by-side office rooms.

Experimental conditions differed with respect to the visual format of the route presentation: (1) in the map condition, floor maps were shown in which the route was indicated by a line, (2) in the picture condition, a sequence of pictures of decision points along the route were shown (Fig. 1), and in the animation condition, (3) an animation showed the movement through the virtual building from the egocentric perspective.

Fourty-eight participants took part in the study (age M = 23.8; SD = 4.4). In each condition, 16 participants (8 female, 8 males) took part. Each participant was tested individually. Participants did not know the computer science building. They were paid for participation. Participants were shown the route instructions on a tablet PC at the beginning of the route. Presentations were of the same duration in each of the conditions. Participants then navigated to the destination without further assistance. In the present naturalistic scenario, they could also use information given in the environment (e.g., room numbers). The experimenter walked behind the participant and measured critical wayfinding errors (way lost) at decision points.

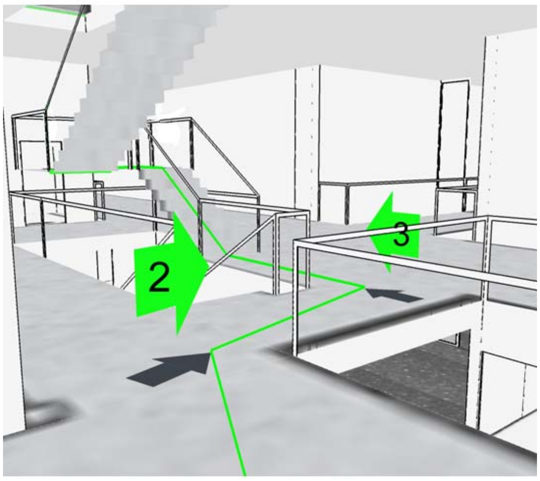

Fig. 1. Example picture of the picture condition.

Results

Overall, 62 % of the participants made no critical wayfinding errors on the entire route, while 38 % of the participants made one or more (up to five) critical wayfinding errors. The number of critical errors differed between route instruction conditions (Table 1), non-parametric Kruskal-Wallis test, qui-square ($df = 2$) = 6.835; $p < .05$. In addition, the number of participants who made critical errors in the different route instruction conditions was considered. Nine out of 16 participants who had received floor maps made critical wayfinding errors, and seven out of 16 participants who had seen pictures made critical wayfinding errors. In contrast, only two participants out of 16 who had seen animations made critical errors. These numbers differed significantly, median test, chi-square ($df = 2$) = 6.933, $p < .05$. The numbers of critical wayfinding errors made by women vs. men did not differ significantly.

Table 1. Numbers of critical wayfinding errors made by women and men in the experimental conditions.

	Maps	Pictures	Animation
Women	10	9	2
Men	9	5	0

Discussion

Results demonstrate a clear advantage for showing the animated virtual walk. About half of the participants who were provided either with (allocentric) maps or with (egocentric) sequences of pictures of decision points lost their ways. The advantage of the animated condition might be explained with the form of information transmission about complex turns. Turning movements on stairs, turns immediate after leaving the stairs, as well as U-turns were critical points at which errors were likely to occur. The animation transmits turning information through the movement of the virtual camera. In contrast, the same information is transmitted symbolically (by showing arrows, Fig. 1) in both of the other conditions. Presumably, participants did not succeed in encoding and memorizing these symbols while passively viewing the picture sequences or the map. In contrast, when viewing the animation passively, the turning information was successfully learned due to the "analogous" transmission of that information by virtual camera movements without active encoding.

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