COMPARING METHODS FOR INTRODUCING BLIND AND VISUALLY IMPAIRED PEOPLE TO UNFAMILIAR URBAN ENVIRONMENTS

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Abstract

This paper reports two experiments which compared the effectiveness of different methods for introducing blind and visually impaired people to the spatial layout of urban environments. In Experiment 1, 30 blind and visually impaired adults learnt a long and complex route through an area of central Madrid (Spain) either by direct experience or by a combination of direct experience and a tactile map or a combination of direct experience and a verbal description of the area. Performance on measures of practical spatial knowledge and of representational spatial knowledge was significantly better in participants in the tactile map condition. In Experiment 2, participants learnt a similar route in an area of Sheffield (Britain) using either just a tactile map or by direct experience. No significant difference was found between the two conditions using the same measures as in Experiment 1.

Introduction

Orienting oneself in an environment and moving around rapidly, efficiently and independently is a difficult task, which depends upon a series of processes of relatively high cognitive complexity, including the perception, coding, learning and recall of spatial information (Espinosa, 1994; Ochaíta & Espinosa, 1996; Espinosa & Ochaíta, 1998). At the same time, both activities require a person to access or recall different kinds of previously acquired environmental knowledge, such as general knowledge about the space, specific strategies for the acquisition, structuring and integration of spatial information, and ‘spatial products’—more or less structured schemas or representations of familiar environments (Liben, 1988). This task is made considerably more complicated in the case of blind and visually impaired people as one of the main problems for these people is acquiring knowledge of surrounding space. When people can move and orient themselves in the environment safely and autonomously, they are more likely to have a sense of security and independence, two essential elements for their integration in a complex society. For this reason, research on how blind and visually impaired people construct cognitive maps of their environments and on the most effective methods for teaching visually impaired people about space is a primary objective both from applied and theoretical points of view.

It has been shown in a number of studies that blind and visually impaired people have difficulty in constructing an accurate and spatially integrated mental representation of their environment from direct locomotion alone (Rosa & Ochaíta, 1993; Spencer et al., 1989). A greater quantity of highly detailed spatial information can be taken in by the visual system than by the sensory systems used by blind and visually impaired people (i.e. touch, hearing, smell). Thus visual information requires less work to integrate it into a well-structured cognitive map of the area compared with information from the remaining senses. Therefore, wayfinding becomes a minutely detailed and effortful task for the blind or visually impaired navigator.
This has implications for ontogenetic development of cognitive mapping skills in children who are born blind, in that more intensive and guided exposure to the spatial structure of the environment is required (Juurmaa, 1973). It is also clear from studies on the microgenetic development of cognitive maps of particular novel areas in blind and visually impaired adults that blind and visually impaired people use different and often less effective means for processing spatial information (Miliar, 1982, 1988, 1994; Rieser et al., 1982, 1986; Ungar et al., 1996b).

Some researchers working with sighted adults have found that learning about space is highly related to the instructional method used (Hirtle & Hudson, 1991). For example, when people learn a space using a map or a panoramic verbal description, the resulting spatial schemas are better coordinated than when the space is learnt through direct interaction with the environment or from a sequential verbal description (Thorndyke & Hayes-Roth, 1982). In previous research with blind and visually impaired people we have shown that tactile maps can be a useful means of providing them with complex spatial information about the environment (Ungar et al., 1993, 1995, 1996a, b).

In previous studies (Ochaita et al., 1991; Ochaita & Huertas, 1993; Espinosa, 1994) we have shown that a person’s spatial knowledge depends on various factors: factors related to personal characteristics (age, cognitive development, perceptual modality used for coding spatial information), factors related to the characteristics of the environment (size, structure, familiarity, etc.) and factors related to learning processes (strategies for knowledge acquisition, learning conditions, medium for communication of spatial information). We felt it important to study the effect of different instructional methods for teaching visually impaired people about space, while also taking into account the nature of uptake of spatial information through the remaining perceptual systems of visually impaired people (Hollyfield & Foulke, 1983).

Several authors (e.g. Passini & Proulx, 1988; Spencer et al., 1989) have pointed out that visually impaired people can make use of certain perceptual cues (auditory, tactile, etc.) to acquire, code, store and recover spatial information. Using these alternative strategies, visually impaired people can move and gain efficient knowledge of space. For this reason we can assert that visually impaired people can organize spatial information in a functionally equivalent way to sighted people. However, given the characteristics of perceptual systems other than vision, this task requires more time (Rieser et al., 1986) and more cognitive effort (Byrne & Salter, 1983) than the same task would for sighted people.

To this end, we designed Experiment 1 in which using a tactile map and learning a route via a verbal description were combined with direct experience. From the results of the experiment we decided to compare, in Experiment 2, the effectiveness of each of the methods which had been more successful in Experiment 1—direct experience and tactile map—when applied separately.

**Experiment 1**

**Method**

Participants. The participants were 30 visually impaired adults who were blind from before 6 years of age. The age of the participants was from 22 to 40 years of age, with an average age of 29 years 3 months. None of the participants had any remaining vision that could be effectively used during the experiment. The experimental group was selected from the total population of adults attending the Mobility and Orientation Centre of the Spanish Organization for the Blind in Madrid, who had no associated physical and psychological problems. All of them had received orientation and mobility training, and so could move in space independently and efficiently. Thus, they were included on the basis of availability. Each of the participants was randomly assigned to one of the three experimental conditions.

Procedure. The participants were required to learn a real, unknown, long (2.05 km) and complex route in an urban environment in a central district of Madrid (Spain) over four sessions in two consecutive days. Therefore, the participants received two learning sessions on the same day with a period of...
1 h between them. The route included eight landmarks, all of which were important points of reference in the district (see the route and the explanation in Figure 1). All of the landmarks could be recognized by kinaesthetic, auditory, tactile or olfactory cues. There were kinaesthetic cues when the landmark was situated at the top of a slope, on a curve, or on some stairs (landmarks 3, 4, 6 and 7). Auditory cues were given by traffic changes or by other changes from the environment, such as people, children, pigeons, etc (landmarks 1, 2, 3, 4, 5, 6, 7 and 8). The kind of information provided by such cues which is readily used by blind navigators includes the approach to a major road intersection (increasing traffic noise ahead), passing a school (sound of many children playing) or the approach to a square (the sound of flocks of pigeons). Tactile cues were given by the different textures of the ground, or when the participant came into contact with some point of reference (landmarks 2, 3, 5, 6, 7 and 8). There were also olfactory cues when the landmark was situated in a garden (landmarks 2, 5 and 7).

Before the training sessions began, the experimenter informed the participants that she would guide them along the route during the first session,
but that in the subsequent three sessions they would have to guide her. The participant always walked holding the instructor’s arm to feel secure.

Direct experience condition: the participant had to walk freely along the route. The instructor guided him or her through the entire route, but without giving any additional information about the environment. Only when the participant arrived at each of the eight landmarks did the instructor give him or her the name of the landmark of the route. This condition was similar to the traditional method of instruction used by most Orientation and Mobility (O&M) professionals, often based on an assumption that blind people can only learn and remember routes as a kind of one-dimensional ‘motor program’ consisting of memory for a sequence of forward movements and turns. Thus, O&M professionals tend to teach their service users about the environment by giving them repeated direct experience of a route or of several interlinked routes.

Tactile map condition: the participants carried a tactile map of the route (scale 1:5000) which they could study whenever necessary while they walked along the route. The map was made by a skilled teacher of orientation and mobility from the Spanish Organization for the Blind (O.N.C.E.). The map represented, on a sheet of thermoform (25 x 30 cm), the area in which the route was traced. The streets were raised up and labelled with a number. The route was represented by a dotted line and the landmarks were represented by different letters. We also gave the participant two sheets of thermoform, one of which had the name of the landmarks and their corresponding letter written in Braille, the other included the name of the streets and their corresponding number. The map was placed on a rigid surface to allow the participants to read it more easily.

Verbal description condition: in this instructional condition, as in the previous one, the participants had more information than in the direct experience condition, because while they were walking through the route, the instructor described it verbally. The verbal description was sequential: when the participants arrived at each landmark, the characteristics of the route between this landmark and the next were described. Spatial and temporal references were included in this description (see example in Appendix).

The participants only received these instructional methods during the first session. In the other sessions, the participants did not receive any additional information. At the end of the first session the participants were then guided by the experimenter to the start of the route along an alternative path. Once there, the experimenter told them that they must retrace the same route which she had taught them previously.

The participants’ behaviour was video-recorded in all sessions. The information from these recordings was combined with behavioural maps which were traced by the instructor as she accompanied the participants. The behavioural maps were records of the participants’ actions and spatial behaviour. The experimenter drew, on a map of the route, exactly the way that the participant was walking in the real environment.

During sessions 2 and 4 the participants were asked to make direction estimates from points 4

<table>
<thead>
<tr>
<th>Session</th>
<th>Direct experience condition</th>
<th>Tactile map condition</th>
<th>Verbal description condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning session</td>
<td>Participants walk along route</td>
<td>While participants walk along route</td>
<td>While participants walk along route</td>
</tr>
<tr>
<td></td>
<td>guided by the experimenter</td>
<td>guided by the experimenter, they can</td>
<td>guided by the experimenter,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>consult a tactile map</td>
<td>they are given a verbal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>description of the route</td>
</tr>
<tr>
<td>Test Session 2</td>
<td>Participants walk the route</td>
<td>Participants walk the route</td>
<td>Participants walk the route</td>
</tr>
<tr>
<td></td>
<td>unguided</td>
<td>unguided</td>
<td>unguided</td>
</tr>
<tr>
<td></td>
<td>At the end of the session</td>
<td>At the end of the session</td>
<td>At the end of the session</td>
</tr>
<tr>
<td></td>
<td>participants plan and walk short cuts</td>
<td>participants plan and walk short cuts</td>
<td>participants plan and walk</td>
</tr>
<tr>
<td></td>
<td>(not previously travelled) between</td>
<td>(not previously travelled) between</td>
<td>short cuts (not previously</td>
</tr>
<tr>
<td></td>
<td>three points of the route</td>
<td>three points of the route</td>
<td>travelled) between</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>three points of the route</td>
</tr>
<tr>
<td>Test Session 3</td>
<td>Participants walk the route</td>
<td>Participants walk the route</td>
<td>Participants walk the route</td>
</tr>
<tr>
<td></td>
<td>unguided</td>
<td>unguided</td>
<td>unguided</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Session 4</td>
<td>Participants walk the route</td>
<td>Participants walk the route</td>
<td>Participants walk the route</td>
</tr>
<tr>
<td></td>
<td>unguided</td>
<td>unguided</td>
<td>unguided</td>
</tr>
<tr>
<td></td>
<td>At the end of the session</td>
<td>At the end of the session</td>
<td>At the end of the session</td>
</tr>
<tr>
<td></td>
<td>participants plan and walk short cuts</td>
<td>participants plan and walk short cuts</td>
<td>participants plan and walk</td>
</tr>
<tr>
<td></td>
<td>(not previously travelled) between</td>
<td>(not previously travelled) between</td>
<td>short cuts (not previously</td>
</tr>
<tr>
<td></td>
<td>three points of the route</td>
<td>three points of the route</td>
<td>travelled) between</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>three points of the route</td>
</tr>
</tbody>
</table>

TABLE 1 Outline of the procedure for the three instructional methods used in Experiment 1
and 8 of the route to all the other points of the route using a portable pointing device with which the participant could estimate the direction to other locations relative to their current position and heading. At the end of both sessions the participants were asked to determine what we called a ‘test short cut’. This task consisted of finding an alternative route to the taught one, that also must be as short as possible, to connect three of the eight points of the route. The test short cuts were filmed on video and traced on a behavioural map for later analysis, as in the learning sessions. The procedure is summarized in Table 1.

Measures

Measures of practical spatial knowledge. The video recordings and behavioural maps were analysed using two different measures of practical spatial knowledge, which had proved effective in previous studies by our research team Ochaita et al., 1991; Huertas & Ochaita, 1992; Espinosa, 1994.

‘Metres off route’: the distance in metres which the participant walked off the route. The actual distance which the participant walked off the taught route (2.05 km) was calculated by applying the appropriate scale transformation to measurements taken from the maps of the participants routes in every session. The off-route distance was measured in millimetres on the map and was converted to a real world distance by applying a ratio of 1:5000.

‘Deviations from route’: the number of times the participant went off route. This task consisted of finding an alternative route to the taught one, that also must be as short as possible, to connect three of the eight points of the route.

‘Direction estimates’: calculated by finding the difference in degrees between each of the direction estimates made by participants during the fourth session and the true direction of the target.

‘Quality of short cut’: a score of four was given if the optimal short cut was chosen (i.e. the shortest possible city block distance), a score of two for correct but suboptimal route (i.e. one which correctly linked the start and end points but which was longer than the optimal route) and a score of zero for an incorrect route.

The measurements used are summarized in Table 2.

Results

An analysis of variance (ANOVA) was carried out on the data from the fourth session to determine the effect of the instructional conditions on the practical and representational spatial knowledge of our participants. The results showed a significant effect of the different conditions on practical and representational spatial knowledge (see Table 3) which was observed on all measurements used in this study (p < 0.05). Tukey multiple comparison tests revealed that the participants who learnt the route by using a tactile map walked fewer metres off the route and deviated from the route fewer times than did the other two groups. Similar results were found on representational spatial knowledge; the participants who learnt the route using a tactile map had smaller error scores on direction estimates and higher quality short cuts than the other two groups.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Metres off route</th>
<th>Number of deviations from route</th>
<th>Quality of short cut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct experience</td>
<td>275</td>
<td>2.00</td>
<td>52†</td>
</tr>
<tr>
<td>Tactile map</td>
<td>50*</td>
<td>0.00*</td>
<td>41**</td>
</tr>
<tr>
<td>Verbal description</td>
<td>462</td>
<td>2.25</td>
<td>55†</td>
</tr>
</tbody>
</table>

* p < 0.05.

TABLE 2

Measurements taken in each session in Experiment 1

<table>
<thead>
<tr>
<th>Session</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning session</td>
<td>—</td>
</tr>
<tr>
<td>Session 2</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>Session 3</td>
<td>1, 2</td>
</tr>
<tr>
<td>Session 4</td>
<td>1, 2, 3, 4</td>
</tr>
</tbody>
</table>

1 = Metres walked off the taught route; 2 = Number of deviations from the taught route; 3 = Direction estimates; 4 = Quality of short cut.

TABLE 3

Mean scores of the effect of instructional conditions on practical and representational spatial knowledge
The results of this experiment show that participants who learnt the route from a combination of direct experience of the environment and a tactile map of the area attained better knowledge of that environment (both practical and representational) than those participants who received only direct experience or a combination of direct experience and a verbal description of the route. In other words, participants in the tactile map condition gained a cognitive map of the area, not only in the loose sense of procedural knowledge about how to find a route through an area, but also in the stronger sense of a mental representation with survey map-like properties (as indicated in performance on short cut and direction estimation tasks). In contrast to the performance of this group, it seems unlikely that the participants in the direct experience condition or in the verbal condition gained a sufficient cognitive representation of the route to enable them to complete the route without the assistance of the experimenter.

Since the effect of using a tactile map was so strong on all the measures of spatial knowledge, we carried out Experiment 2 to determine whether the use of a tactile map on its own (i.e. learning a route from a tactile map before having any direct experience of the environment) would have as strong a facilitatory effect on spatial knowledge when compared with direct experience on its own. Experiment 2 aimed to replicate the direct experience condition of Experiment 1 and compare it with a new condition in which the participants learned a route from a tactile map before walking the route.

**Experiment 2**

Method

Participants. Ten blind and visually impaired adults took part in the study. The age of the participants was from 20 to 47 years of age, with an average age of 31 years 5 months. Six participants were totally blind and five had some residual vision. None of the participants had any remaining vision that could be effectively used during the experiment, although one participant had sufficient vision for the detection of obstacles in the immediate environment. Seven participants were blind from birth or before 7 years of age and the rest were later blinded. Five of the participants used a long cane, four had a guide dog and one participant used no aid at all.

Procedure. All participants learned two similar routes (both were 1.2 km in length and had 13 decision points) in one area of Sheffield (U.K.) (see Figure 2) by one of two instructional methods: direct experience or using a tactile map. All participants learned both routes, but a different instructional method was used for each. Order of presentation of routes and instructional method were balanced across participants.

Tactile maps of the areas were constructed using the microcapsule process at a scale of approximately 1:3000. The maps represented the road layout using single, 3-point lines to represent roads and showed some landmarks which would be relevant to a blind or partially sighted traveller—grass verges, tree-lined pavements, and roundabouts.

We will describe the instructional methods used in this experiment because although we use the same terms as in Experiment 1, there were important differences with respect to the quantity and...
quality of information that was given about the space.

In the direct experience condition, participants walked freely along the route, using whatever mobility aid they were accustomed to, while the experimenter walked alongside giving directions both shortly before and at each decision point. In contrast to the procedure in Experiment 1, the experimenter also answered any questions the participant had about the route. After this learning session, participants were guided by the experimenter to the start of the route by an alternative path (i.e., they did not take the most direct route back to the start, and did not retrace the route).

In the tactile map condition, the participant was handed a tactile map at the start of the route and was asked to explore it until they had a reasonable impression of the layout. The map symbols were explained to the participant as they were encountered on the map. The experimenter then placed the participant’s finger on the start point of the route and moved the participant’s finger along the route. This procedure was used, rather than verbally describing the route as the participant scanned the map, to avoid any map-specific uses of directional labels, such as ‘right’ and ‘left’, which may have confounded the subsequent wayfinding exercise. This procedure was repeated until the participant could trace the route twice unaided. Order of presentation of the instructional conditions was counterbalanced.

After the learning session, participants were asked to walk the learned route unguided (Test Session 1), while the experimenter followed and noted on a map of the area the exact route taken by the participant. Participants in the tactile map condition carried the map with them during this phase of the experiment. If participants walked off the route during either of the test phases, they were allowed to walk as far as the next road junction, where the experimenter stopped them and led them back to the previous on-route junction. If the participants did not know how to continue from this point, the experimenter told them which way to go. At the end of Test Session 1, participants in the tactile map condition returned the map to the experimenter. Participants were then guided by the experimenter to the start of the route by an alternative way.

During Test Session 2, participants were also stopped at points along the route and asked to make a total of eight direction estimates to other points on the route (using an identical procedure to that used in Experiment 1). Specifically, participants were asked to point to the end of the route from the start and from points 1, 2 and 3, and they were asked to point to the start of the route from points 1, 2, 3 and from the end of the route (see Figure 2).

After Test Session 2, participants were led to a point on the route (marked ‘a’ in Figure 2) and were asked to find a short cut to another point on the route (marked ‘b’ in Figure 2), i.e., to get from the first point to the second without retracing their steps along the taught route. These latter measures (direction estimates and short cut) provided data on the representational knowledge which the participants had gained of the area, beyond knowledge of the actual taught route. The procedure for the two instructional conditions is summarized in Table 4.

### Measures

From the tasks which the participants carried out, we calculated the same measurements that we used in Experiment 1: metres off route and number of

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**Table 4**

Outline of the procedure for the two instructional methods used in Experiment 2

<table>
<thead>
<tr>
<th>Session</th>
<th>Direct experience condition</th>
<th>Tactile map condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning session</td>
<td>Participants walk along route guided by the experimenter</td>
<td>Participants explore a tactile map of the area, and are shown the route on the map</td>
</tr>
<tr>
<td>Test Session 1</td>
<td>Participants walk the route unguided</td>
<td>Participants walk the route whilst carrying a map</td>
</tr>
<tr>
<td>Test Session 2</td>
<td>Participants walk the route unguided. Direction estimates are obtained. At the end of the session participants plan and short-cuts (not previously travelled) between two points of the route</td>
<td>Participants walk the route unguided. Direction estimates are obtained at the end of the session participants plan and walk short-cuts not previously travelled between two points of the route</td>
</tr>
</tbody>
</table>
TABLE 5
Measurements taken in each session in Experiment 2

<table>
<thead>
<tr>
<th>Session</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning session</td>
<td></td>
</tr>
<tr>
<td>Test Session 1</td>
<td>1, 2</td>
</tr>
<tr>
<td>Test Session 2</td>
<td>1, 2, 3, 4</td>
</tr>
</tbody>
</table>

1 = Metres walked off the taught route; 2 = Number of deviations from the taught route; 3 = Direction estimates; 4 = Quality of short cut.

deviations from the route as measures of practical spatial knowledge; and direction estimates and quality of short cut as measures of representational spatial knowledge. The measures used in Experiment 2 are summarized in Table 5.

Results

Sixteen separate analyses of variance were carried out. For each of the two measures of practical knowledge, one 2-factor (instructional method × trial) ANOVA and three 3-factor (participant characteristic × instructional method × trial) ANOVAs were carried out, where ‘participant characteristic’ was degree of impairment (totally blind or residual vision), age at onset of impairment (early or late) and mobility aid (long cane or guide dog), respectively, in the three analyses. For each of the representational measures, one 1-factor (instructional method) and three 2-factor (participant characteristic × instructional condition) analyses of variance were carried out.

The results of these analyses showed that there were no significant differences between any of the measures of spatial knowledge (practical or representational) in respect of the variables analysed in Experiment 2: instructional condition, degree of impairment, age at onset of impairment and mobility aid used. Table 6 presents the scores of the participants in the two instructional conditions.

Discussion

To clarify the discussion of the results of these studies, we will first describe the results from each experiment separately, and then suggest some conclusions to synthesize both sets of results.

Experiment 1

From the results of Experiment 1, we can conclude that the instructional conditions resulted in clear differences in the practical spatial and representational knowledge of an unknown environment in a group of visually impaired adults.

The participants who used tactile maps as a supplementary aid to direct experience, showed more accurate spatial behaviour and more coordinated and integrated spatial schemas than those participants who did not carry a map or who received a verbal description of the route. The results of this experiment are consistent with studies carried out with sighted people in which the authors state that direct experience is a useful method for acquiring spatial knowledge (Lindberg & Gärling, 1983). Over three learning sessions, the participants’ spatial behaviour and representation improved between the second and the fourth session. This can be attributed to their interaction with the environment. However, when participants had access to the spatial information on a tactile map, used as a supplementary aid to direct experience, this facilitated mobility and orientation in the space. When the supplementary information consisted of a verbal description of the route, the results were different. Auditory information about the route did not facilitate the spatial knowledge of the participants relative to those who learned the route by direct experience.

Experiment 2

Overall, the participants performed just as well after exploring a tactile map as they did after direct experience in the environment. In session 1, participants who carried a map performed as well as others who had already had direct experience of the entire route. In session 2, the map group (now relying on the memory of the map that they carried

<table>
<thead>
<tr>
<th>Condition</th>
<th>Metres off route</th>
<th>Deviations from route</th>
<th>Direction estimates</th>
<th>Quality of short cut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct experience</td>
<td>35.9</td>
<td>0.4</td>
<td>42.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Tactile map</td>
<td>64.1</td>
<td>0.8</td>
<td>36.6</td>
<td>0.9</td>
</tr>
</tbody>
</table>
in session 1) still performed as well as the direct experience group (who had the benefit of two complete journeys along the route prior to the second trial). These results suggest that tactile maps, with even quite a brief exposure, are an effective means for introducing blind and visually impaired people to the spatial structure of a novel area. The results are surprising, as it has generally been believed that blind people lack the spatial skills to use tactile maps, such as the ability to appreciate the aerial perspective of a map or to apply a scale transformation necessary to relate the map to the real world. However these results with adults confirm those of previous studies in which blind children used tactile maps to navigate successfully in smaller experimental environments (e.g. Ungar et al., 1994; Ungar et al., 1996a, b).

Comparison of Experiments 1 and 2

In Experiment 1 the use of the tactile map generated better practical and representational knowledge of the space, while in Experiment 2 there were no differences between the two instructional conditions. However, these apparently contradictory results may easily be explained within a transactional or contextualist theoretical model (Altman & Rogoff, 1987; Stokols, 1987; Altman, 1992). Within this perspective it is not possible to talk of spatial knowledge without taking account of the more general context in which it is produced. The knowledge which an individual has about an environment at a particular moment depends on many factors relating to the individual, the space itself, the learning task itself, and the culture or microculture in which this knowledge is situated, as well as the complex transactions that take place between all these factors.

The map conditions of Experiment 1 and Experiment 2 were quantitatively and qualitatively different. Although they were labelled the same in both cases, the type of information that they provided to the participants was different. In the map condition of Experiment 1, the participants carried the map with them while they walked the route, and they could consult it as often as they thought necessary, whereas in Experiment 2 they had to learn the map before entering the real space. Learning a route on a map, in this case a tactile one, in order to subsequently move about in a real environment is a complex task which requires memorizing a large amount of information. But at the same time, this task implies a series of high level abilities for blind people such as understanding the scale of the map and extrapolating a series of two dimensional relationships learned from the map to a three dimensional space. So, if in Experiment 2 the map condition required the deployment of a series of abilities which were complex for the blind participants (which made spatial learning much more difficult compared with the way the map was used in Experiment 1), one would expect less difference between instructional conditions in Experiment 2.

The number of training sessions that the participants received in both experiments was different. If, as we have argued in other parts of this paper, such spatial knowledge which a person has of an environment at a particular time depends on the complex transactions in engagement with that environment, then the quantity of exchanges that the person has with the environment must necessarily determine any differences with respect to the knowledge that he or she has about the environment. The more opportunities a person has to interact with an environment, the more chances there will be to organize the spatial information acquired from that environment (because spatial schemas are modified and produced each time they are used and recalled), and that the information will be recalled efficiently on occasions when it is needed. In this way, the participants in Experiment 1 who received a greater number of training sessions had more chance of showing differences between the different instructional conditions. Closely related to this argument is the idea that the participants learned from the tasks that they had to perform during each of the training sessions. Again, we note that while the participants in Experiment 1 had to estimate directions and find a shortcut in the second and fourth sessions, the participants in Experiment 2 only performed these tasks in the second session.

The usefulness of tactile maps for teaching visually impaired people from an early age about space, has been demonstrated in several studies (Ungar et al., 1993). In Experiment 1 the use of a tactile map resulted in increased configurational knowledge of the environment, relative to direct experience. Analysis of the representational measures of Experiment 2 (direction estimates and of scores on the short cut exercise) gave no evidence of such an advantage. It seems likely from this that the participants in Experiment 2 used the tactile map purely as a means of following the route, and ignored the overall layout. It is possible that longer exposure to the map, perhaps with the addition of explicit instructions to attend to the overall layout, might have resulted in an advantage of the map on
the representational measures. As we argued earlier, such survey knowledge would support freer and more flexible wayfinding.

Although no facilitatory effect of using a map was found in Experiment 2, there are important practical consequences of the fact that performance in the two experimental conditions did not differ significantly for any of the measures of spatial knowledge. This suggests that a tactile map can be at least as effective as direct experience for gaining spatial knowledge of an urban environment. Compared to the conventional method of direct familiarization with an area, which is very time-consuming, a map can be studied before going to the area. It is possible for a visually impaired person to use a tactile map to familiarize themselves with an area, thus potentially reducing their dependence on carers.

Conclusion

We argue that the combination of two procedures (direct experience and tactile maps) constitutes a useful procedure which should be used by orientation and mobility instructors. The joint use of the two procedures may overcome any limitations of each method used in isolation. For this reason we would stress the value of using a procedure which combines both methods. However, in situations where it is impractical or impossible to provide guided direct experience, then even a tactile map used in isolation can be an adequate means of familiarizing oneself with an environment.

The results of this study have clear practical implications for blind and visually impaired people. First, they paint a more optimistic picture of their potential to acquire cognitive maps of urban environments which can be used effectively and flexibly. In relation to this, tactile maps can potentially increase the independence and autonomy of blind and visually impaired people, in that a tactile map can be used to navigate through a complex urban environment without any assistance from a sighted guide.

Finally, the results have implications for the way in which orientation and mobility professionals instruct their service-users. As we have pointed out previously, tactile maps are rarely if ever used in O&M practice. Our study indicates that tactile maps can be an extremely effective additional aid in the process of teaching a blind or visually impaired person about a route or about the spatial structure of a novel area.

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Note

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(1) As only one participant used no mobility aid, it was not possible to include this data in the analysis.

References


Blind and Visually Impaired People Learning Routes


Appendix 1:

Example of verbal description:
route between landmarks 1 and 2

(We are standing on the corner of Castelletó and Padilla streets. This is the first landmark of the route.)

'We are standing at the first landmark of the route, Juan March Foundation. It is a modern building situated on the corner of Castelletó and Padilla streets. Many exhibitions of painting and sculpture are shown in this building...‘Castelletó and Padilla streets are both one-way streets...'

(We continue walking, and we arrive at the traffic light.)

'Now we cross Castelletó street and we continue walking on the right pavement...'

(We arrive at the corner between Principe de Vergara and Padilla streets.)

'Now we turn to the left, we cross Padilla street and we continue walking on Principe de Vergara. This is a very broad, two-way street...'

'We have arrived at Nuestra Señora del Rosario Hospital, the second landmark of the route. This hospital is surrounded by a fence and it has a nice garden...'