Finnish Journal of eHealth and eWelfare

SCIENTIFIC PAPERS

VERTAISARVIOITU
KOLLEGIALT GRANSKAD
PEER-REVIEWED
www.tsv.fi/tunnus

Tactile maps – Finnish O&M instructors' experiences on usability and accessibility

Stina Ojala[1], Riitta Lahtinen[2,3], Helinä Hirn[3]

[1] Department of Future Technologies, University of Turku, Turku, Finland; [2] ISE research group, University of Helsinki, Helsinki, Finland; [3] O&M consultant, private entrepreneur

Stina Ojala, Department of Future Technologies, University of Turku, Turku, FINLAND. Email: stina.ojala@utu.fi

Abstract

For a person with a visual impairment, the quality of life means independence and equality with the sighted people. For this, independent travel and navigation is essential. Orientation within different types of environments is a challenge and tactile maps are key elements for this. It can also be used for learning about new routes independently. A tactile map is an image of spatial information and figure that uses raised lines and surfaces when introducing a certain area in 3D form. For a public tactile map to be useful, it has to contain consistent information for the user.

In this study we present results from a survey for the orientation and mobility (O&M) instructors of Finland about usability and ideas for improvement concerning public tactile maps. We sent the survey questionnaire for 30 O&M instructors by electronic mail and there was also a possibility to answer by paper. Altogether we received 24 answers. The main finding was that most of the O&M instructors did not use public tactile maps during the sessions.

Keywords: visual impairment, tactile maps, orientation and mobility instruction, blindness

Introduction

Maps are used to learn about an area and planning routes within it [1]. Different targets are depicted by using map symbols that are based on common agreements although the symbols sometimes may vary from one map to another [2]. This variability between symbols from one map to another affects readability especially in tactile maps. What does that derive from? Is it due to different manufacturing procedures or merely a lack of guidelines? The preferable ways in trying to develop good practices for tactile map production and going towards international standards for tactile map manufacturers are 1. gathering end user comments on usability of existing maps and 2. ideas for improvements.

In this paper we present the results of a questionnaire represented for the O&M instructors in Finland concerning the availability and usability of public tactile maps in Finland (appendix 1). The maps in the article are currently used in O&M instruction with people with visual impairment: those with low vision and those who are blind.

Maps for low vision and blind users

Tactile maps use raised surfaces so that persons with visual impairment can feel and recognize the lines and shapes of the figures. The aim of the tactile map is to convey information of the space and environment by the sense of touch. The sense of touch also conveys the orientation in the environment via proprioception. The design of tactile maps follows the same guidelines as those used in visual maps, but the basic image must be edited for haptic exploring [3,4,5]. A tactile map cannot be a translation of visual information into tactual form as the tactile sense cannot provide the same resolution as the eye. A tactile map is a raised, specially adapted tactile representation of the specific cartographical location in question.

All the following tactile map examples represent the same meeting room. These maps are used in testing the individual's sense of touch - what kind of map materials are the easiest to process, which are the most salient features and how do the different patterns indicated within the map relate to memory traces when actually moving around within the room [6]. The results from tests like these made by individual O&M instructors would relate to important background information for the process of standardisation. Furthermore, there are extracartographical restrictions for a tactile map: the materials used should be resistent to wear and tear as well as pleasant to touch. The extracartographical factors are easier to gather, but unfortunately the information is dispersed within the O&M instructor profession and not as yet collected.

Collage maps

Collage maps (Figure 1.) are made of different materials, e.g. strings, buttons, and cloth placed onto a basic simple map [7]. This technique enables a joint process of transfer from a room or a space into a joint tactile map. In this type, the client and the O&M instructor are equal in producing the map - as the client chooses the materials it gives a fascinating insight on the traceability of tactile support for memory patterns within a space.

Thermoform maps

Thermoform maps (Figure 2.) are vacuum formed maps which require a master mold with raised lines, figures and other elements and additionally a thin thermoplastic sheet that is heated, and placed over the master then stretched and moulded forming a tactile map [6]. The surface material is the same throughout the map, but there is a limited possibility to indicate height differences. This type is smooth and slippery, which could affect its pleasantness to touch. This map type does not support low vision use without post processing.

Figure 1. A collage map using different materials.

Figure 2. A thermoform map.

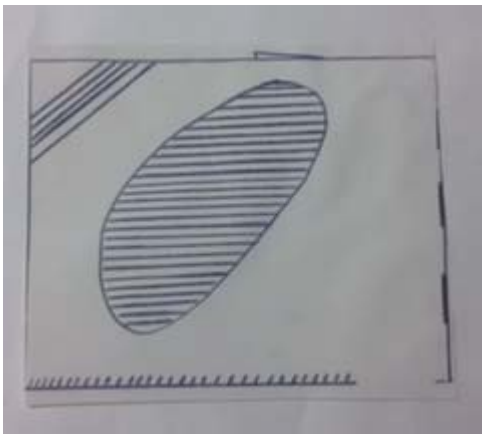

Figure 3. A swell paper map.

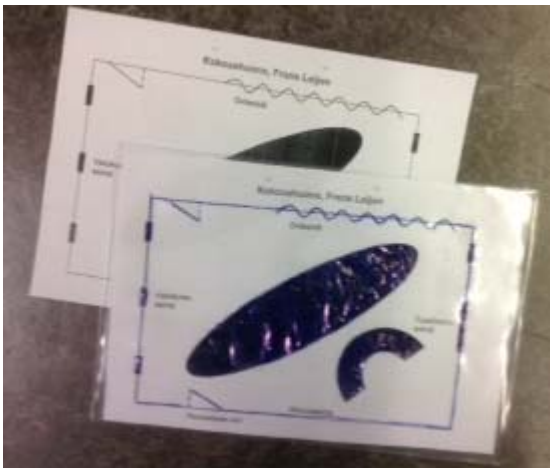

Figure 4. A Ritmuff sheet map.

Swell paper maps

Swell paper maps (Figure 3.) are either hand-drawn or printed figures, which are copied onto heat-sensitive microcapsule paper [6]. The marks on the paper covered by black ink raise above the paper surface creating a raised line drawing. This map original is easy to produce with black pen and white paper. The lines on the original need to be spaced far enough for the result to be distinguishable with touch. This map type is less expensive to produce, but the map is not well resistant for wear and tear.

Ritmuff-sheet based tactile maps

Ritmuff-sheet (Figure 4.) is a semi-transparent plastic sheet which is placed on a rubber mat [6]. Figures can be drawn using a pen that leaves a raised line on the sheet. This type of map is easy to produce on-the-go, that is within a single O&M session when using and learning a new route.

Factors affecting readability of tactile maps

The factors affecting readability of maps differ in visual and tactile maps. In a traditional tactile map how the map feels is more important than what it looks like [8,9,10]. It would be essential to create coherent guidelines for tactile map design. The guidelines should take into account the differences in age, vision and other abilities of the potential users. The design should take into account and include the map size and format, the choice of symbols and the scale [11]. The current article tackles these questions based on a questionnaire on existing public tactile maps in Finland and their usability and use within O&M instruction procedure.

In tactile maps readability is affected in two different scopes: tactile and low-vision readability. Often tactile maps are designed for low vision users as well. In this article we focus on tactile readability and it is affected by abundance of information - too much information results in low readability. Placement and orientation of the map affects readability as well. It is important that the tactile map is placed in such a way in the premises that the orientation points and the actual points of interest (POIs) match in direction. Furthermore, the acoustic cues within the premises help in confirming the orientation of the map. While visual maps can be easily used outside as well as inside in tactile maps weather conditions affect readability of them [10]. This is more poignant in the north where snow and cold weather can hinder readability of the map drastically.

In tactile maps the orientation of the map in the surrounding can greatly affect its readability in terms of physiological restrictions in using one's hands. That is a

map upright on the wall can be less readable because of the restrictions in flexing muscles of the wrists. On the other hand, if a map is erected horizontally there is a possibility people start using it as a table surface. That means maps should be erected inclined to prevent its use as a table surface. Desirable characteristics of tactile maps are durability, sharpness and width of borderlines, surface texture, recognisable symbols, and availability. Maps can be located and available in various places, and they should withstand abrasive use, chemical exposure, and adverse weather conditions. At the same time they should be pleasant to touch, consistent in symbol representation and they should have distinguishable lines to trace. The maps should be well situated so that there are tactile guiding strips to the location from the entrance and further on to other locations [5].

The usability features form three categories: functional, code-related and those based on tactile information processing [12]. Functional notes relate to the functions of the map, such as the information on the map and distribution of the text within it. A tactile map should only contain map-related information. The map legend should be placed outside the map drawing, that is, there should not be text within the map drawing. The code-related features include change of codes. If there are more than one code it results in too much information for a tactile reader of the map. All the information should be consistently displayed in all coding systems. Also, the use of Braille matrices to indicate textures in the map is not desirable as it indicates a change of code to reading text. There should only be one symbol per one POI. The tactile information processing features include arrangement of information and patterns on the map. Patterns should be well distinguishable, also information should be well orderly.

Tactile maps in education and rehabilitation

There are different tactile maps for different purposes. This article concentrates on maps in connection to O&M instruction process. Wherever there is a tactile map, the processing and reading of the map serves exactly the same purpose: to orientate oneself in the surroundings and to find out the routes within, to familiarise oneself with the environment [6]. The context is always the same, to process the information from the map and map it into the environment. When a person with a visual impairment reads a map, the reading process might start with the map legend, the compass directions and the scale (if available), then the general framework before starting to explore the details [6]. Studying the map is quicker when studying it with an O&M instructor or a sighted guide. Braille is used in tactile maps all over the world.

Tactile maps in O&M instruction

Tactile maps are an essential element in O&M instruction. The aim of O&M instruction is learning to travel in familiar and unfamiliar environment independently and safely [13]. The O&M instruction covers training in mobility techniques, in sensory skills, in community and environmental awareness in concept and motor development as well as in orientation skills [6]. Thus, the pedagogical adaptations for the blind and low vision users of maps have to be taken into account when teaching the students or adults in rehabilitation to benefit from tactile maps. For the visually impaired tactile maps are also a safety issue [14].

The basic prerequisites for using public tactile maps in O&M instruction process are: 1. the maps exist, 2. O&M instructors know their locations, 3. they contain useful and coherent information, 4. the O&M instructors are informed about new tactile maps installed, and 5. they are easy to find and get to. A tactile map is of no use if it is not known about. The information contained has to be coherent and useful and updated. The map needs to be kept clean. The two last facts are most often ignored. These facts result the map being not used and thus not useful and not fulfilling its purpose [6].

The symbols of the map should at minimum be explained in a map legend and they should be found consistently at the same location within a map. The traditional tactile maps are, when erected, always there and not dependent of internet connections. But even though there would be a tactile map on the premises, it

might become non-usable due to external parameters, such as advertisements, movable tables or chairs restricting access to the map. The route from the entrance to the tactile map should be marked with tactile guiding strips so that the map can be found independently.

Questionnaire for O&M instructors about tactile maps in public areas

In order to gather more knowledge about usability of tactile maps in public areas we made a survey for the O&M instructors in Finland. The survey included a questionnaire distributed by electronic mail list and in paper format at a workshop for O&M instructors in Finland (appendix 1). The questionnaire included both background information and specific questions about usability of tactile maps in O&M instruction process for clients with diverse types of visual impairment. Background questions included information about location of the clients or working area of the instructor and the age distribution of the clients.

Specific questions about the use of tactile maps in instruction process included questions about types of tactile maps in use as well as the improvement suggestions for advance of use of tactile maps in public buildings and areas. Most of the interviewees were using collage maps using different types of materials. The problem with these maps is that they are most often self made for one specific client and for one-off situation and/or route and cannot be used but a few times. Also, some of the instructors used other methods for route description. These, however, share the same problems as the self-made maps.

Background information

In the survey we got 24 answers back from the 30 questionnaires sent to O&M instructors. Based on the background questions of the survey 96% of the people who answered had been working as O&M instructors for more than 10 years and more than three times a week. Most of the responses indicated that the person worked mainly with children or mainly with adults, but there were also responses which indicated working with both children and adults 50/50%. Most of the answers indicated working either in Southern or South-Western Finland and there were no responses from Northern Finland. The questionnaire response percentage was 75%, but the distribution coverage of the questionnaire may not be representative of all O&M instructors in Finland. It does, however, give an indication of the trends for the professionals.

Open questions about tactile map use

Most of the responses indicated the use of self-made, tailored tactile maps. The techniques used included collage, combined use of different materials and creative use of a single material. The maps were made both for single use and multi-purpose use. The single-use maps can be tailored even further and even more individually than multi-purpose use.

Only 4 out of 19 respondents used public tactile maps in the O&M instruction process. The most common reasons given for not using public tactile maps were that the locations are not well-known and that the clients felt they were not very useful for them. Other reasons given were the lack of standardization of symbols between different tactile maps and the fact that most often there is too much information in the map resulting in decreasing the readability of the map. The contributing factor to the information load might be that the tactile maps are directly transferred from visual maps without further consideration for the characteristics and function of sense of touch. One answer highlighted the lack of time - the map reading takes time to learn.

The use of tactile maps in O&M instruction concentrated on the learning of routes. Some of the answers indicated use of tactile maps in orienting oneself into a space and when learning about wider contexts. Maps were also important in learning about basic facts about traffic, including intersection shapes and public transport routes in connection to a city plan or a suburban section with several options for public transport.

Solutions for use and usability

Most of the answers showed concern for different clients' needs for different types of maps with regard to detail and generalisation. Also, as there are not so many public maps available, one does not get practice in reading different types of public tactile maps. It's different when one deals with individualized, tailored tactile maps, but those are usable for only a single or maximum 2-3 people. There was a need for manufacturing and building tactile maps from a solution-centered perspective as well as a need for light-weight, portable maps similar to visual maps, so that one could take them with him/her and study them along the route. The most important places for public mapping were public transport stations and shopping centres. Usually the tactile maps are erected stationary so that one needs to go back to them to study them further to check a certain location. There was a need for tactile maps that one could take along in addition to the stationary tactile maps on site.

Conclusions

There is no systematic convention about the place of the map legend on a tactile map but it depends on the manufacturer of the map. For example in Finland there are maps that have map legend information scattered to different places on the map. This decreases map's readability. Another issue is that the symbols differ from one map to another. There is a distinct need for a standardised, international set of symbols to be used in tactile maps worldwide. This discrepancy of symbols and its difficulty is further highlighted if the person trying to decipher the maps is not a Braille reader as not all people with visual impairment can read Braille. Braille map legends are incomprehensible for non-Braille readers.

It is also utterly important that the map is placed in such a way that it can be found easily and the place is calm enough for a person to stay there to study it. Often in construction phase the architect wants a certain scheme to the building and that also includes the visual design of the tactile map. However, this is not the optimal solution for a tactile map as there are certain features that differ from visual to the tactile perception. Tactile maps should not be judged by visual standards but according to the characteristics of the sense of touch. To have a map correctly updated is also a safety feature [14].

Future vistas

Thanks to advances in technology, map making for people with visual impairment can provide a range of products (e.g., tactile, and audio-tactile maps) that can improve their independence, self-confidence and everyday life as well as safety, e.g. information of emergency exits in hotels or public venues. Also when tactile maps are incorporated into daily travels, then they are practiced on daily basis and not only used in connection to O&M instruction a couple of hours per week within one or two month period. Current technology allows e.g. to develop such audio-tactile maps where audio beacons provide short messages and information within the environment. This is proposed as a valuable tool in the acquisition of orientation and mobility skills in a novel geographical area [15].

Cartographers and architects may suggest and realise their own solutions for tactile maps, which may or may not be compatible with tactile end users' needs. It is especially important to have constant contacts between people with low vision or blindness (end users) and designers and to make usability tests with different end users groups.Therefore there is a need for further discussion on tactile map standards. It is important to bring cartographers, tactile and low vision end users, O&M instructors teachers of students with visual impairment and map manufacturers and producers together to discuss and decide on standards for tactile map manufacturing and most of all symbols used in tactile maps, so that tactile maps would be more coherent in Finland and later also internationally. There are currently more and more tactile maps in public areas and venues, so the need for standardization cannot be highlighted enough.

References

[1] Parente P, Bishop G. BATS: the blind audio tactile mapping system. In: Proceedings of the ACM Southeast Regional Conference 2003. p. 132-137.

[2] Eriksson Y, Jansson G, Strucel M. Tactile map symbols. Enskede, Sweden: The Swedish Library of Talking Books and Braille; 2003. p. 54-57.

[3] Eriksson Y. Att känna bilder [To feel pictures]. Solna, Sweden: SIH Läromedel; 1997. p. 84-87.

[4] Eriksson Y, Wollter S. Från föremål til taktil bild [Converting the object into a tactile picture]. Lycksele, Sweden: Tryck Nya Tryckeriet; 1997. p. 31–41.

[5] Gardiner A, Perkins P. 'It's a sort of echo...': Sensory perception of the environment as an aid to tactile map design. The British Journal of Visually Impairment 2005, 23(2), 84–91. https://doi.org/10.1177/0264619605054780

[6] Hirn H. Pre-maps: An educational programme for reading tactile maps. Academic dissertation. Helsinki: University of Helsinki; 2009.

[7] Dacen-Nagel DL, Coulson MRC. Tactual mobility maps - a comparative study. Cartographica: The International Journal for Geographic Information and Visualization 1990;27(2):47-63. https://doi.org/10.3138/D310-6U13-H13J-H414

[8] Aldrich FK, Sheppard L. Tactile graphics in school education: perspectives from pupils. British Journal of Visual Impairment 2001;19(2):69-73. https://doi.org/10.1177/026461960101900204

[9] Andrews SK. Applications of a cartographic communication model to tactual map design. The American Cartographer 1988;15(2):183-195. https://doi.org/10.1559/152304088783887008

[10] Ojala S, Lahtinen R, Hirn H. Tactile maps - safety and usability. In: Li H, Nykänen P, Suomi R, Wickramasinghe N, Widén G, Zhan M (eds). Building Sustainable Health Ecosystems. WIS 2016. Communications in Computer and Information Science, vol 636. Springer, Cham; 2016. p. 15–22. https://doi.org/10.1007/978-3-319-44672-1_2

[11] Rowell J, Ungar S. The world of touch: An international survey of tactile maps. Part 2: design. The British Journal of Visual Impairment 2003;21:105–110. https://doi.org/10.1177/026461960302100304

[12] Gardner EP, Kandel ER. Touch. In: Kandel ER, Schwartz JJ, Jessell TM. Principles of Neural Sciences. NJ: MacGraw-Hill; 2000.

[13] Hill EW, Ponder P. Orientation. Orientation and mobility techniques: A guide for the practitioners. NY: American Foundation for the Blind; 1976.

[14] Lahtinen R, Palmer R, Ojala S. Practice-oriented Safety Procedures in Work Environment with Visually and Hearing Impaired Colleagues. Safe and Secure Cities. Proceedings of 5th International Conference on Well-Being in the Information Society, WIS2014. Turku, Finland, August 18-20, 2014. p. 109-120. https://doi.org/10.1007/978-3-319-10211-5_12

[15] Jacobson RD. Talking tactile maps and environmental audio beacons: An orientation and mobility development tool for visually impaired people. Aberystwyth, UK: Institute of Earth Studies, University of Wales; 1966.

Appendix 1. Questionnnaire on use of tactile maps in Orientation and Mobility (O&M) instruction

Stina Ojala, Riitta Lahtinen & Helinä Hirn

Background information

1. How long have you been working as a O&M instructor?
    - 1-3y
    - 4-6y
    - 6-9y
    - 10y or more

2. How often and to whom do you do O&M instruction?
    - Adult population in %?
    - Children and youth population in %?

How often do you give instruction sessions?
    - More than once a week
    - About once a week
    - Several times a month
    - About once a month
    - If less, how many sessions a year?

3. Where in Finland do you work (region/s)?
    - Åland Islands
    - South Karelia
    - South Ostrobothnia
    - South Savonia
    - Kainuu
    - Tavastia Proper
    - Central Ostrobothnia
    - Central Finland
    - Kymenlaakso
    - Lapland (Finland)
    - Päijänne Tavastia
    - Pirkanmaa
    - North Karelia
    - North Osthrobotnia
    - North Savonia
    - Satakunta
    - Uusimaa
    - Finland Proper

4. Are you aware about public tactile maps being available in your area?

Questions about tactile maps

5. Do you use tactile maps in O&M instruction?
    - Yes
    - No

6. If yes, what kind?
    - Public tactile maps
    - Self-made maps
    - “copy-paste” method
    - Drawn, swell paper maps
    - Lego maps
    - Maps using other materials
    - Temporary, non-stable maps using materials nearby

7. How do you use tactile maps in O&M instruction?

8. Do you use different types of tactile maps in different situations?

9. If you are not using tactile maps, why not?

10. Solutions for using more tactile maps in O&M instruction

11. Improvements for existing tactile maps?

12. Should there be more tactile maps in public areas?
    - Yes
    - No

13. If yes, what type of tactile maps would you wish there were?

14. If you want to use tactile maps in O&M instruction and cannot manufacture them yourself, are you aware of where to get them?

15. Do you use other types of mapping in O&M instruction, such as verbal maps or drawing on the body?