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Design and Evaluation of a Protocol to Assess Electronic Travel Aids for Persons Who Are Visually Impaired

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Abstract: This study evaluated a protocol that was developed to assess how beneficial electronic travel aids are for persons who are visually impaired. Twenty persons with visual impairments used an electronic travel device (Trekker) for six weeks to conform to the protocol, which proved useful in identifying successful users of the device.

Persons who are visually impaired (that is, those who are blind or have low vision) typically experience problems with mobility and wayfinding. Not only can these problems result in limited activity, but they can restrict social participation (Marston & Golledge, 2003). One of the major concerns of persons who are visually impaired with regard to wayfinding is the lack of information they are able to obtain from their environment while traveling and crossing intersections (Loomis, Golledge, Klatzky, & Marston, 2007; Ponchillia, Eniko, Freeland, & La Grow, 2007). Electronic travel aids increase opportunities for independent wayfinding by providing information about the user's current location and with navigational instructions regarding the route to a destination. These devices are intended to be used in addition to, not instead of, a white cane or dog guide.

A number of electronic travel aids are available in the marketplace, including Trekker and BrailleNote GPS (both manufactured by Humanware) (for a recent overview of such devices, see Roentgen, Gelderblom, Soede, & de Witte, 2008). The positive impact that these tools have on the daily lives of people with visual impairments in terms of providing opportunities and promoting independence is promising. For example, Zabihaylo (2008) demonstrated that Trekker stimulated its users to explore new environments and enhanced their sense of security after one year of use. In single-subject experiments with BrailleNote GPS, Ponchillia et al. (2007) found that the device's use can lead to greater wayfinding performance than the use of general orientation and mobility (O&M) skills, even

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in highly familiar areas. These investigators recommended that GPS technology for people who are visually impaired should become part of rehabilitation and educational programs for both the simple and the more complicated functions of the devices.

Learning how to use an electronic travel device independently generally requires a considerable amount of training and motivation, and may not be possible for every individual who is visually impaired. To avoid prescribing a device to a visually impaired applicant who may not benefit from its use, rehabilitation centers and health insurance companies need to consider the efficacy of a device for a potential user before it is purchased. However, as Jutai, Strong, and Russell-Minda (2009, p. 219) stated, as yet there is a "deficit of effective and standardized outcome measures for evaluating satisfaction, success, and performance with assistive technologies." On request of the Dutch Health Care Insurance Board (College voor Zorgverzekeringen, n.d.), we therefore designed and evaluated a two-phase protocol to assess how beneficial a particular electronic travel device is for an individual with visual impairment, with regard to the goal of independent O&M. In Phase 1 of the protocol, the Identification Phase, the characteristics of a person who is visually impaired are tested against identification criteria to identify those who may benefit from the use of an electronic travel device. After the most appropriate device with respect to the person's mobility problems and wishes is selected, the person enters Phase 2, the Intervention Phase, which consists of structured training in the use of the device and repeated tests to assess the person's ability to operate the device. The person is encouraged to use the device frequently between training sessions. On the basis of this two-phase protocol, the decision can be made whether the use of the device meets the individual's reported mobility needs and whether the device should be prescribed. The design of this protocol was based on experiences with a procedure that was used in studies to evaluate the efficacy of a night-vision device (Hartong, Jorritsma, Neve, Melis-Dankers, & Kooijman, 2004; Hartong & Kooijman, 2006).

The study presented here applied this two-phase protocol to the use of Trekker, a GPS system for people who are visually impaired that is available in the Netherlands, and assessed whether the criteria in the Identification Phase were sufficient and appropriate and whether the Intervention Phase could distinguish between poor and adequate users of the device. The study also assessed how much practice and training were necessary before the participants could use the device independently.

Methods

Participants

A total of 46 persons with visual impairments responded to a request for voluntary participation that had been disseminated in the provinces Groningen, Drenthe, and Friesland of the Netherlands. None had prior experience with Trekker. After receiving more information about the project, 34 respondents filled out a questionnaire concerning their degree of visual impairment, independent mobility, mobility demands, and computer use and skills. Following the advice of three O&M instructors from different rehabilitation centers in the Netherlands, we determined a list of criteria for the identification of those who might benefit from the use of an electronic travel device. To qualify for the prescription of a device, a person had to have a visual impairment that impeded the use of common written sources for information on routes, good autonomous mobility skills on familiar routes, a desire to increase his or her independent mobility on familiar routes and to explore new routes independently, good or corrected hearing, and had to use a computer frequently.

Twenty-nine of the 34 respondents fulfilled these criteria. From this group, we chose 20 participants aged 15–68 (mean age 47 years, *SD* 17 years), 14 men and 6 women, covering a wide distribution of ages and various degrees of visual impairment and including those with and without dog guides. Eight participants had moderately to severely low vision (visual acuity below 0.5, Snellen equivalent 6/12) and 12 were blind, 9 of whom had no light perception. Ten participants had been visually impaired from or shortly after birth (early onset) and 10 became impaired later in life (late onset). Eleven participants used just a white cane, 1 used just a dog guide, 6 used both a cane and a dog guide, and 2 used neither a cane nor a dog guide.

Two participants were not frequent (daily or weekly) computer users, and one had low autonomous mobility skills. These participants were included to obtain insights into the validity of the criteria that were used in the Identification Phase. All the other participants used a computer independently at least once a week and had good independent mobility. In addition to the 20 selected participants, two highly experienced, totally blind Trekker users (aged 50 and 60) were invited to participate in the Performance Assessments (discussed later) and to form a reference for the performances of the other participants.

On the basis of their personal experience, all the participants indicated one to three mobility problems that they hoped Trekker would solve. These problems were classified post hoc into six categories: "getting lost" ($n = 6$); "not being able to walk new routes or in new environments" ($n = 11$), "being dependent and insecure" ($n = 7$), "not being able to find a particular location or address" ($n = 7$), "not being able to go out for a walk in the woods or in a park" ($n = 4$), and "lack of knowledge about the streets/no image of the environment" ($n = 4$).

Written informed consent was obtained from all the participants before the study began, and the Ethical Issues Board of the Department of Psychology (University of Groningen, Groningen, the Netherlands) approved the study protocol. The study was consistent with the principles outlined in the Declaration of Helsinki.

Apparatus

Trekker version 3.0, which has been available on the Dutch market since 2003, consists of a handheld computer (personal digital assistant) with a touch screen that is accessible to persons who are visually impaired by means of an overlay keypad and talking menus, a GPS receiver, digital maps, and a speaker. Trekker gives information about the user's current position; announces streets and intersections; and, when a destination has been entered, plans the itinerary and gives detailed route instructions. Moreover, the user can virtually explore a route before walking it. Besides the pedestrian mode, which is used while walking, Trekker can also be used in a motorized mode (useful to individuals riding on public transportation) and in a free mode for navigation in open areas for which a digital map is not available.

Test leaders

The test leaders were 12 third-year undergraduate students who were majoring in psychology. Before the study began, these students received instruction and training in O&M and in escorting a person who is visually impaired from one of the authors (Hanneke van der Velde, a professional O&M instructor). The students received one day of instruction on the use of Trekker from an Optelec instructor. They were closely involved in the development of the training protocol, which was supervised by van der Velde, and practiced with each other for weeks. This approach guaranteed proper treatment of the participants and the thorough familiarity and expertise of the test leaders with both the device and the standardized protocol.

Procedure

The participants used Trekker, on loan from the Dutch distributor Optelec, for six weeks. During this six-week period, they followed a procedure that was designed to conform to the protocol of the Intervention Phase. The participants started the experiment in groups of three to five users with the usual one day of instruction from an Optelec instructor who was blind and highly experienced in explaining and instructing persons who are visually impaired in how to use Trekker on a daily basis. Three additional two-hour individual training sessions were scheduled in the following three weeks and were led by the test leaders. The participants' proficiency in using Trekker was assessed by means of a standardized test ("performance assessment") prior to each individual training session and at the end of the six-week period. The participants were encouraged to use Trekker daily and to keep a diary of their experiences between training sessions. In the two weeks between the last training session and the final performance assessment, the participants were not asked to keep a diary and could use Trekker as often as they wanted to. The O&M problems that the participants experienced were assessed twice by means of O&M questionnaires, once before and once after having used Trekker.

Training sessions

The training sessions were organized into six modules of increasing complexity. Modules could not be skipped and had to be completed in the original order. If necessary, the modules could be repeated. At the start of each training session, the participants' experiences of the previous week (as reported by the participants or registered in their diaries) were discussed, individual problems were solved, and questions were answered. Some of the training took place indoors; the rest was performed outdoors in a quiet residential neighborhood.

Performance assessments

The performance assessments measured the participants' ability to use the Trekker menu and enter a destination, and to understand and use the information supplied by Trekker to navigate the pre-entered routes. A performance assessment consisted of two parts. In the first part, the participant was asked to enter the starting points and the destinations of two different routes. The handling of Trekker was measured as the "time needed to enter a route" (INPUT-TIME) and the "efficiency using the Trekker menu" (MENU-USE). The latter was judged on five items (requests for help, speed of handling, ability to find the keys, use of the menus, and use of the keyboard shortcuts) on a 5-point Likert scale, where a higher score represented better handling of the device.

In the second part of the performance assessment, the participant walked the two pre-entered routes. Both routes were located in a residential area near the Department of Psychology, with short blocks, low buildings, and little traffic. The four performance assessments that a participant completed during the study were comprised of four different, but highly comparable, pairs of routes, the order of which was evenly distributed among the participants. "Navigating with Trekker" (NAVIGATING) was judged on four items (general judgment about walking the route, independent problem solving, frequency of hesitation, and requests for help) using 5-point Likert scales, where a higher score represented more efficient and independent use. Moreover, walking speed was measured from the beginning to the end of each route and was expressed as a percentage of the individual's preferred walking speed. Preferred walking speed was measured separately in the final session along a 20-meter (about 66-foot) trajectory in a corridor that was free of obstacles.

During the navigational part of the performance assessment, the participant was always accompanied by two test leaders: one who could be asked for help when the participant did not know how to continue and the other who walked behind the participant to measure the length of time and fill in the observation form. At the end of each route, the test leaders checked whether they agreed on the scores noted on the observation form and, in case of a difference, deliberated to reach a commonly agreed-upon score.

Questionnaires

Aspects of O&M behavior were assessed with an oral questionnaire before the first performance assessment and the first individual training session. The questions covered the participant's mobility behavior, activities, and orientation problems of the previous two weeks and were answered using 4-point Likert scales. The same questionnaire was repeated at the end of the six-week period and focused on the activities and experiences of the two previous weeks in which the participants received no training and could freely use Trekker. In the final session, the participants used a 5-point Likert scale to rate the extent to which using Trekker had solved the O&M problems they had reported at the start of the project and to rate the usefulness of the different training modules.

Results

One individual withdrew after the first instruction session by the Optelec instructor, and 4 of the remaining 19 participants missed one training session and a performance assessment for personal reasons.

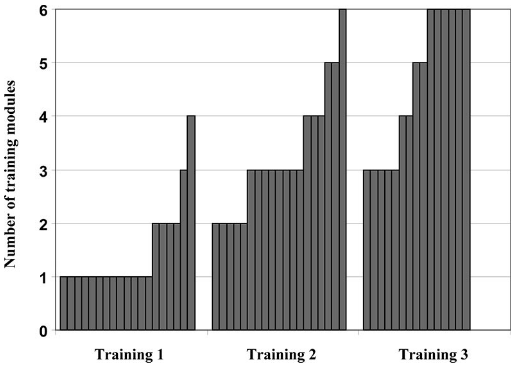

Figure 1. Number of modules that the individual participants, represented by separate bars, had completed at the end of each training session.

Training

Figure 1 shows the highest training module completed per participant for each training session (after the initial group instruction by Optelec). Not every participant managed to complete the sixth module in three training sessions. The slower-learning participants needed an entire training session to complete one training module, while the quickest-learning participants completed five or six modules in only two training sessions. Seven participants were able to complete all the modules within two or three individual training sessions. All the modules were experienced as being moderately to very useful (mean rating per module 4.4; *SD* 0.4, range 3.6–5).

O&M questionnaire

The results of the O&M questionnaire that was completed at the beginning of the study showed that the participants scored their abilities on most O&M aspects before the use of Trekker as being rather high (see Table 1), confirming that the participants fulfilled the criterion of having good independent mobility on familiar routes. The results after six weeks of using Trekker showed significant improvement in 7 of 11 items (pairwise

Table 1
Results of the O&M questionnaire before and after having used Trekker for six weeks.

		Rating before using Trekker[a]			Rating after using Trekker			
Number	Question	*M*	*SD*	*N*	*M*	*SD*	*N*	One-sided *p*-value
1	Frequency of having sighted company	3.05	0.62	19	3.58	0.51	19	Less than .01
2	Frequency of going out alone	3.21	0.92	19	3.11	0.81	19	NS
3	Trouble finding address, building, or crossing	3.17	0.82	15	3.15	0.80	15	NS
Familiar routes and situations								
4	Feeling independent	3.35	0.49	18	3.53	0.72	18	NS
5	Feeling safe	3.36	0.48	18	3.58	0.52	18	Less than .05
6	Orientation problems (general)	3.37	0.60	19	3.79	0.42	19	Less than .01
7	Orientation problems (per situation)	3.45	0.52	17	3.67	0.48	17	NS
Unknown routes and situations								
8	Feeling independent	2.00	0.88	15	2.76	0.65	15	Less than .01
9	Feeling safe	2.04	1.07	13	2.54	0.75	13	Less than .05
10	Orientation problems (general)	1.11	1.49	18	2.11	1.45	18	Less than .01
11	Orientation problems (per situation)	0.67	1.07	12	1.74	1.60	12	Less than .05

Note. Questions 3, 4, 5, 7, 8, and 11 all consisted of 3–4 subquestions about different situations; reported values are the mean scores for these subquestions. NS = not significant.
[a] 1 = low and 4 = high level of orientations and independent mobility.

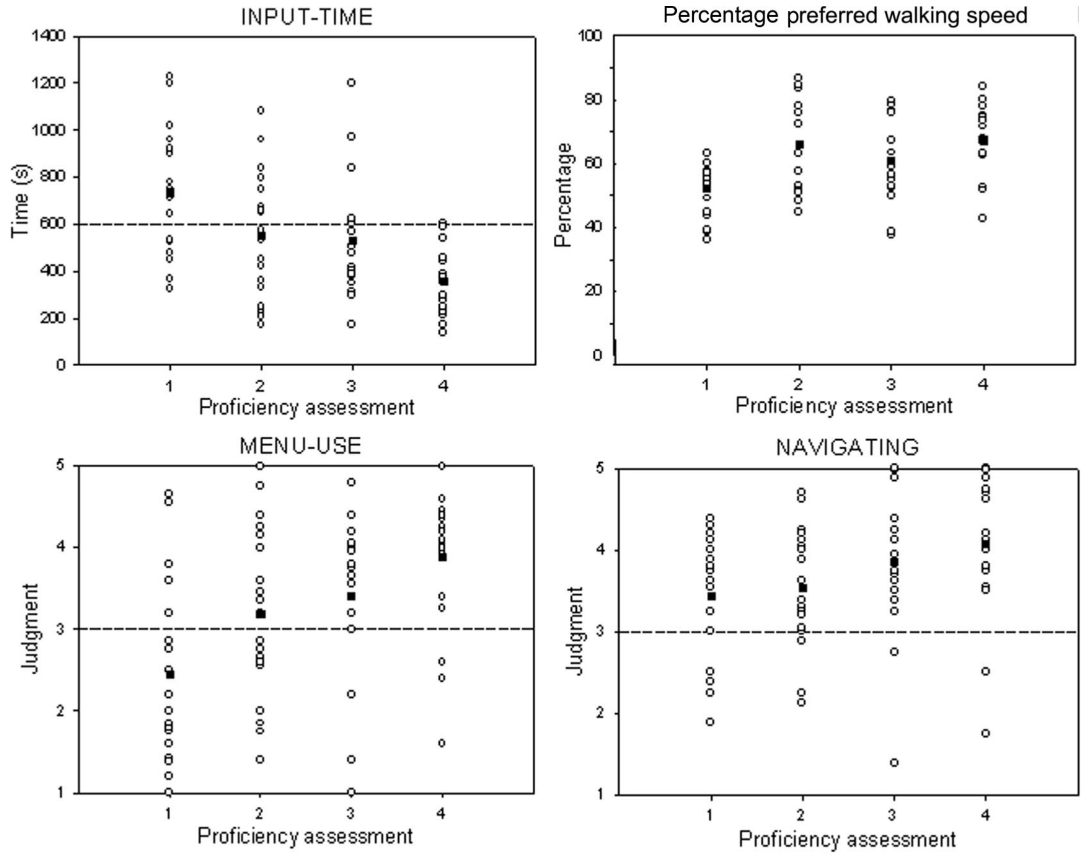

Figure 2. Group results of proficiency assessments. *Note:* Black squares indicate group means per proficiency assessment. Dotted lines represent cutoff scores for sufficient independent use of the Trekker.

t-test, one-sided *p*-value $< .05$). Significant improvement was found mainly on items concerning unfamiliar routes (Questions 8–11).

Performance assessments

The results of the four performance assessments are presented in Figure 2. All the variables showed an improvement in performance from the first (PA1) to the fourth (PA4) performance assessment. Statistical analyses were performed using the GLM repeated-measures procedure. The results of the four performance assessments were significantly different at the 99% level for all the variables. INPUT-TIME (for entering both the start and destination addresses) decreased from 735 seconds at PA1 (*SD* 269 seconds) to 358 seconds at PA4 (*SD* 138 seconds): $F(3.39) = 14.32$; $p < .001$. The judgment score for MENU-USE was calculated per participant using the mean score of the five separate items and increased from 2.45 at PA1 (*SD* 1.12) to 3.88 at PA4 (*SD* 0.91): $F(3.42) = 15.65$; $p < .001$. The percentage of preferred walking speed increased from 52.4% at PA1 (*SD* 8.6) to 67.3% at PA4 (*SD* 12.7): $F(3.36) = 5.82$; $p < .01$. The judgment score for NAVIGATING was calculated per participant using the mean score of the four separate items and increased from 3.45 at PA1 (*SD* 0.8) to 4.08 at PA4 (*SD* 0.9): $F(3.39) = 5.69$; $p < .01$. Bonferroni-corrected pairwise comparisons showed significant differences between PA1 and PA4 for all the variables ($p < .05$).

To define what should be considered "sufficiently independent use of Trekker," we determined cutoff scores for the performance assessment variables INPUT-TIME, MENU-USE, and NAVIGATING. The variable percentage of preferred walking speed was not included as a criterion variable, since Trekker can improve a participant's (feeling of) autonomous mobility no matter how long it takes the individual to reach a destination. For the variable INPUT-TIME, less than 600 seconds was considered a reasonable cutoff value, since all 19 participants needed at most 600 seconds to enter a route at PA4 (compared to 6 participants at PA1, 11 at PA2, and 12 at PA3). As a reference, both the highly experienced blind Trekker users needed a mean time of 330 seconds to enter a route. The mean time needed by the participants at PA4 was 358 seconds. The cutoff values for MENU-USE and NAVIGATING were set at a score of 3 or higher. In comparison, the two experienced Trekker users scored 4.2 and 4.8 on MENU-USE and 4.8 and 5 on NAVIGATING. The cutoff value of each assessment is represented by the dotted lines in Figure 2.

The participants whose results were as good as or better than the cutoff scores for at least two of the three variables were considered sufficiently capable of using Trekker independently. At the first performance assessment (before the additional training sessions), 6 of 18 participants met the criterion for sufficiently independent use of Trekker. At PA2 (after one additional training session), 11 of 19 participants met the criterion. This number increased to 13 of 17 participants at PA3. At PA4 (after three additional training sessions), 15 of 18 participants could be classified as being sufficiently capable of using Trekker independently.

When we inspected the relationship between the scores for PA1 and PA4 and the independent factors of age, visual impairment, onset of visual impairment, use of a dog guide, and frequency of computer use, we found that the scores of the PA1 and PA4 were significantly related to age. The younger participants had better scores for "efficiency using the Trekker menu" at PA1 ($r = -0.590$, $p = .010$) and needed less time to enter a route at PA4 than did the older participants ($r = 0.489$, $p = .046$). The scores were also related to the onset of visual impairment: The participants with an early onset of their visual impairment needed less time to enter a route at PA4 than did those with a late onset ($r = 0.486$; $p = .048$).

Degree of improvement in mobility problems

The "inability to find a particular location or address" (100%), the problem of "getting lost or not knowing where you are" (83%), and "being dependent and insecure" (53%) were reported by most of the participants as having improved (see Table 2). When the improvement of at least one mobility problem was rated 3 or higher on a 5-point Likert scale, it was decided that the participant's mobility problems were at least partly solved and that Trekker could offer a proper and adequate solution for

Table 2
Rating of improvement in mobility problems.

Mobility problems mentioned at the start	Number of participants mentioning the problem	Mean improvement score[a]	No. of scores greater than or equal to 3
Getting lost or not knowing where you are	6	3.7	5 (83%)
Inability to walk new routes or to walk in new environments	11	3.0	5 (45%)
Being dependent and insecure	7	2.6	4 (53%)
Inability to find a particular location or address	7	3.9	7 (100%)
Inability to go for a walk in the woods or in a park	4	2.5	2 (50%)
Lack of knowledge about the streets or no image of the environment	4	3.3	1 (25%)
Total	39	3.2	24 (77%)

[a] 1 = no improvement to 5 = much improvement.

his or her mobility situations. This was the case for 15 participants.

Discussion

The aim of the study was to develop and evaluate a two-phase protocol to assess how beneficial a particular electronic travel device is for people who are visually impaired. In the Identification Phase, 20 participants were selected who might be eligible for the prescription of a device. Nineteen participants used this device for six weeks, conforming to the protocol of the Intervention Phase. In addition to the standard instruction given by the supplier, three training sessions were provided. At the end of the Intervention Phase, the functionality of the device for each individual user was determined by his or her ability to use the device independently, as assessed with performance assessments; and the usefulness of the device, as defined by an improvement in the participants' earlier experienced mobility problems. In this study, a reduction in mobility problems was judged by the participants themselves; in a "real-life" setting, such a judgment would be made in consultation with an O&M instructor.

The protocol for the Identification Phase consisted of five criteria, which were met by nearly all the participants. One criterion, frequent computer use, is often assumed to be necessary to master the handling of Trekker's elaborate interface (Guide Dog Foundation for the Blind, n.d.; Zabihaylo, 2008). One participant, however, did not use a computer independently, but was sufficiently able to use Trekker unaided at the final performance assessment, and another participant with sufficient computer experience, but little autonomous mobility, did not reach this level of independent use. This latter participant was unable to walk without assistance much farther than 200 meters (about 66 feet) and thus could not independently complete the assignments. Therefore, we recommend that good autonomous mobility should be included in the list of identification criteria and that sufficient computer experience, although it may facilitate mastery of the Trekker menu, should not be used as a strict requirement.

Use of Trekker had a positive influence on the O&M of most of the participants in the study, especially when unfamiliar routes were taken. The results of the O&M questionnaires showed that, in general, the participants felt more independent and safe when they used Trekker, and that they experienced fewer orientation problems on unfamiliar routes.

The results of the training sessions that were conducted during the Intervention Phase differentiated well the participants who mastered the use of Trekker in one or two training sessions, those who showed a gradual increase in their abilities to the highest module level during the project, and those who showed less progress and did not proceed further than the third training module. The standard instructions given by the Optelec instructor plus one week of practice at home was insufficient for most of the participants to fulfill the criteria for the independent use of Trekker. Since there was no control group that received only standard instructions and no additional training sessions, it is unclear whether the participants' improved scores on the performance assessments was due mainly to the additional training sessions or to practicing at home. In any case, the training modules were appreciated and rated as very useful by the 14 participants who filled out the evaluation questionnaire at the end of the study. In comparison, in the United States, the Guide Dog Foundation for the Blind (n.d.) offers its clients a training program that generally lasts three to four days, with classroom sessions and practical lessons on the street. Another project, the GPS Project (Special Education Technology, British Columbia, 2007), which studied 12 students using Trekker, offered two days of training. The students and their instructors reported that step-by-step lessons are needed to become proficient in using the device.

The protocol of the Intervention Phase allowed for the identification of 15 of 19 participants who were able to use Trekker independently at the end of the project. Thirteen of these 15 indicated that one or more of the mobility or orientation problems that they initially mentioned had been solved or ameliorated with the use of Trekker. As a result, following the protocol for the Intervention Phase, Trekker can be considered a beneficial electronic travel device for those 13 participants.

Conclusion

For financing institutions (such as insurance companies), as well as rehabilitation centers and the applicants themselves, it is useful, if not necessary, to have guidelines on how to decide whether a certain electronic travel device will be beneficial for an applicant. This study has shown that not all persons who are visually impaired will profit to the same extent from an electronic travel device like Trekker. Some will not be able to master the use of the device sufficiently, while others will not experience a satisfying improvement in their particular mobility situation.

The results of the study support the use of a two-phase protocol: an Identification Phase and an Intervention Phase. According to this protocol, at least three individual training sessions should be provided, stimulating the applicants to learn to use the selected electronic travel device independently before they decide to purchase it. A habituation period of at least six weeks gives the applicants the opportunity to demonstrate and experience whether the device is the proper solution for their particular situation. The functionality of the device should be assessed by measuring the applicants' skills and ability to use the device independently and the reduction in their mobility problems. Doing so will avoid the purchase of an electronic travel device that will not be frequently used in the long run.

References

College voor Zorgverzekeringen [Dutch Health Care Insurance Board]. (n.d.). *CVZ and the Dutch health care system.* Retrieved from http://www.cvz.nl

Guide Dog Foundation for the Blind. (n.d). *The Guide Dog Foundation offers Trekker training.* Retrieved from http://www.guidedog.org/progserv/Trekker/overview.htm

Hartong, D. T., Jorritsma, F. F., Neve, J. J., Melis-Dankers, B. J., & Kooijman, A. C. (2004). Improved mobility and independence of night-blind people using night-vision goggles. *Investigative Ophthalmology & Visual Science, 45,* 1725–1731.

Hartong, D. T., & Kooijman, A. C. (2006). Night-vision goggles for night-blind subjects: Subjective evaluation after 2 years of use. *Ophthalmic and Physiological Optics, 26,* 490–496.

Jutai, J. W., Strong, G., & Russell-Minda, E. (2009). Effectiveness of assistive technologies for low vision rehabilitation: A systematic review. *Journal of Visual Impairment & Blindness, 103*, 210–222.

Loomis, J. M., Golledge, R. G., Klatzky, R. L., & Marston, J. R. (2007). Assisting wayfinding in visually impaired travelers. In G. L. Allen (Ed.), *Applied spatial cognition: From research to cognitive technology* (pp. 179–202). Mahwah, NJ: Lawrence Erlbaum.

Marston, J. R., & Golledge, R. G. (2003). The hidden demand for participation in activities and travel by persons who are visually impaired. *Journal of Visual Impairment & Blindness, 97,* 475–488.

Ponchillia, P. E., Eniko, C. R., Freeland, A. L., & La Grow, S. J. (2007). Accessible GPS: Reorientation and target location among users with visual impairments. *Journal of Visual Impairment & Blindness, 101,* 389–401.

Roentgen, U. R., Gelderblom, G. J., Soede, M., & de Witte, L. P. (2008). Inventory of electronic mobility aids for persons with visual impairments: A literature review. *Journal of Visual Impairment & Blindness, 102,* 702–724.

Special Education Technology, British Columbia. (2007). *The GPS Project.* Retrieved from http://www.setbc.org/news/docs/gpsproject.html

Zabihaylo, C. (2008, July). *GPS systems: Great wayfinding tools*. Paper presented at Vision 2008, the 9th International Conference on Low Vision, Montreal, Quebec, Canada.

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