☑ CE Article

The Effect of the Usage of Computer-Based Assistive Devices on the Functioning and Quality of Life of Individuals Who Are Blind or Have Low Vision

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Structured abstract: *Introduction:* The Israel Ministry of Social Affairs and Social Services subsidizes computer-based assistive devices for individuals with visual impairments (that is, those who are blind or have low vision) to assist these individuals in their interactions with computers and thus to enhance their independence and quality of life. The aim of this study was to examine the effect of computer usage on the quality of life of computer-based assistive device users, and to evaluate their capacity to carry out computer-based tasks. *Methods:* The study was conducted between the years 2013 and 2015. Questionnaires were provided to 96 randomly sampled individuals with visual impairments. These questionnaires were designed to collect information about the quality of life, types and frequency of computer use, satisfaction with the assistive devices, and the effects of computer-based assistive device usage on the participants' lives. In addition, the study evaluated participants' performance in tasks such as e-mail use, Internet surfing, and the use of Microsoft Word; participants performed these tasks on their personal computers. The research sample accounts for about 10% of visually impaired persons in Israel. *Results:* Findings suggest that participants use computer-based assistive devices frequently (four hours a day on average), primarily for leisure (three hours on average). Participants also report high satisfaction with their devices (mean of 3.98 out of the maximum score of 5.00) and indicate that the devices have improved their quality of life (mean 3.67 out of 5.00) and leisure activities (mean 3.68 out of 5.00). Participants display high levels of task performance, especially in the use of Microsoft Word software (mean of 3.47 out of 5.00), and e-mail usage (mean of 3.81 out of 5.00). *Discussion:* The findings suggest that most participants use computer-based assistive devices daily and report a positive influence from them on their quality of life and activity. *Implications for practitioners:* The study suggests that welfare services and assistance organizations would benefit from subsidizing computer assistive devices for individuals with visual impairments.

Computer-based assistive devices are tools designed to enable individuals with visual impairments (that is, those who are blind or have low vision) to interact with computers. In Israel, the Ministry of Social Affairs and Social Services provides a significant subsidy to the cost of these devices, with the aim of enabling visually impaired individuals to improve their general functioning and increase their independence and quality of life (Gleitman, 2014). The aim of this study was to examine the extent of computer-based assistive device usage among individuals in Israel, and the effect of device usage on users' levels of functioning and independence, as well as on their quality of life.

The effect of assistive devices on the functioning and quality of life of individuals with visual impairments has been examined in numerous studies. For example, a study by Scott, Smiddy, Schiffman, Feuer, and Pappas (1999) indicated that the use of devices significantly improved the quality of life of individuals with visual impairments. Similar results were obtained in studies by Dahlin-Ivanoff and Sonn (2004); Gerber (2003); and Horowitz, Brennan, Reinhardt, and MacMillan (2006). However, a review conducted by Alper and Raharinirina (2006) concluded that people with visual impairments do not significantly benefit from the use of assistive technology. In addition, Jutai, Strong, and Russell-Minda (2009) obtained mixed results regarding the effectiveness of blind rehabilitation through the use of assistive technologies in relation to various aspects of users' lives. Therefore, it cannot be assumed that the use of assistive devices will result in effective rehabilitation.

Some of these findings may be surprising because computers and Internet access enable people to connect to the world around them (Leventhal, 2003). Such connections are expected to be particularly important to visually impaired individuals, who often report experiencing social isolation. Therefore, accessibility to information is crucial in assisting these individuals and improving their lives (Beverley, Bath, & Barber, 2007). As computer and Internet usage have become integral to daily life, especially over the last 20 years, it is crucial to ensure that people with disabilities are not left behind the rest of society (Gerber & Kirchner, 2001).

Numerous studies have also investigated computer usage among individuals with visual impairments (Boulton, 1989; Chiang, Cole, Gupta, Kaiser, & Starren, 2005; Gerber, 2003; Kelly, 2009, 2011; Kelly & Smith, 2011; Kennel, Perrochon, & Darvishi, 1996; Wong & Cohen, 2011; Zhou, Parker, Smith, & Griffin-Shirley, 2011). These studies measured two types of outcomes: *effective contribution,* a term referring to the extent to which the use of computer-based assistive devices resulted in improvements in various functions;

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and *subjective effect,* a term referring to the impact of computer-based assistive device usage on quality of life, as reflected in users' level of satisfaction. In other words, the latter measure reflects how a disabled person perceives the change in his or her lifestyle brought about by technology that provides access to the computer world and the Internet.

Many other studies have examined the practical effects of computer-based assistive devices on the functioning of individuals with visual impairments. Wentz, Hochheiser, and Lazar (2010) found that many visually impaired people have made use of assistive devices. In a study conducted in Israel, Inbar (2005) investigated the usage of assistive devices by individuals with visual impairments. About two-thirds of the participants claimed the devices contributed to their independence. Another study in Israel (Inbar, 2005) found that the usage of a braille display enhanced the academic abilities of students. In light of these findings, it seems plausible that assistive devices have the capacity to enhance the learning capabilities of students with visual impairments and to improve their cognitive, emotional, and social development (Wong & Cohen, 2011). In addition, Hayden, Astrauskas, Yan, Zhou, and Black (2011) provided visually impaired students with computer-based assistive devices aimed at assisting them in taking notes in class. The authors reported that the devices indeed facilitated the students' note-taking process and enabled them to increase their participation rates in class.

Several additional reports have investigated the effects of Internet usage on the subjective quality of life of visually impaired individuals. Gerber and Kirchner (2001) argued that this effect is expected to be significant, owing to the social isolation these individuals experience. According to Hooper, Jutai, Strong, and Russell-Minda (2008), assistive devices have a consistently positive effect on daily activities. Inbar (2005) argued that there is a significant link between the quality of life of children and adults with visual impairments and the use of assistive devices.

Yet, a study by Slegers, Van Boxtel, and Jolles (2008) questioned the claim that computer usage affects individuals' well-being. The researchers conducted a study among older adults examining the effects of computer usage on variables reflecting physical, social, and emotional well-being, and functioning in day-to-day activities. The findings indicated that the use of computers and the Internet had no positive or negative effect.

Previous research has also found that individuals with visual impairments do not take full advantage of the availability of computer-based assistive devices and, ultimately, use computers to a lesser extent compared with sighted people (Chiang et al., 2005; Gerber & Kirchner, 2001; Hollier, 2007; Kelly, 2009, 2011; Phillips & Zhao, 1993). There are a number of explanatory factors associated with this lower computer usage.

One significant factor influencing computer usage is age. Gerber and Kirchner found that among individuals with visual impairments, the rate of computer and Internet usage was much lower among those aged 65 years and older (Gerber & Kirchner, 2001). This result is corroborated by van der Geest, van der Meij, and Van Puffelen (2014), who examined the

abilities of young and elderly individuals with visual impairments to surf the Internet. Similar results were obtained in a study by Cutler, Hendricks, and Guyer (2003).

Another factor affecting computer usage among visually impaired individuals is the type of disability. Wessels, Dijcks, Soede, Gelderblom, and De Witte (2003) suggested that there is a fundamental difference in computer usage between individuals who lost their vision and those who were born with visual impairments. The first group have left the "world of vision" behind; for them, technology may not be a sufficient access solution, since it does not restore their previous lives. For the second group, assistive devices open up a whole new world and a variety of options. Usage levels may also differ according to individuals' personalities and attitudes regarding their impairments: compared with individuals with visual impairments who do not use assistive devices, computer-based assistive device users may be more emotionally mature and more motivated, and these may strive more for independence (Wessels et al., 2003).

Although much literature, as noted above, addresses the overall effect of visual impairment on functional status and quality of life (Brown, 1999; Kraut & McCabe, 1994), relatively few studies have examined the skill level of individuals with visual impairments in executing computer- and Internet-based tasks (exceptions include Hollier, 2007; Scott, Feuer, & Jacko, 2002; and Shimomura, Hvannberg, & Hafsteinsson, 2010). A survey conducted by Hollier (2007) that aimed at investigating computer proficiency among individuals with visual impairments found that they were relatively skilled in computer use. Scott et al. (2002) examined differences in computer-based task performance among participants, and they found that visual performance characteristics were significantly associated with participants' capacity to execute the tasks accurately. Shimomura et al. (2010) examined computer usage abilities among visually impaired students who were using voice software or a braille display, and they found that they were able to accomplish basic and short tasks but that they found it difficult to perform complex tasks.

This research examines patterns of computer-based assistive device usage among individuals with visual impairments. Thus far, only a few studies have attempted to empirically examine computer proficiency among individuals with visual impairments and the relationship between computer skills and various aspects of quality of life (Alper & Raharinirina, 2006; Dahlin-Ivanoff & Sonn, 2004; Gerber, 2003; Horowitz et al., 2006; Jutai at el., 2009; Scott et al. 1999). The current research aims to fill this gap. Specifically, the study examined the characteristics of a sample population using assistive devices, and evaluated participants' degree of skill in using these devices and the effects of device usage on their quality of life and level of functioning. In addition, the study examined the level of satisfaction of the study population regarding computer-based assistive devices.

The research questions are accordingly: What is the extent of computer-based assistive device usage among individuals with visual impairments in Israel? and What is the effect of device usage on

users' levels of functioning and independence, as well as quality of life?

Methods

Computer-based assistive devices

Computer-based assistive devices typically function by converting the visual content of the computer screen into a format that is accessible to individuals with visual impairments. There are a number of devices:

- Video magnifiers (closed-circuit televisions) are electronic magnifiers that can be connected to a computer and that enable the user to read text from the screen while regulating the font size and color, contrast, and brightness in accordance with his or her needs.
- Magnification software, when installed on computers, increases the size of items shown on the screen, including the enlargement of graphical interfaces.
- Screen readers (installed software) read the text displayed on the screen or describe the visual display aloud according to where the cursor is located or what a user is typing on the keyboard.
- Braille displays are devices that convert the visual content of text information on the screen into braille characters on a designated output display.

Participants

The study population was composed of individuals with visual impairments who were receiving subsidies for computer-based assistive devices from the Ministry of Social Affairs and Social Services in 2013. According to the ministry, in 2013 about 860 people were receiving such subsidies (Gleitman, 2014).

In total, 96 individuals participated. The sample population was 53% male and 47% female (51 men and 45 women), while the population eligible for computer-based assistive devices subsidies was 55% male and 45% female. Regarding the types of computer-based assistive devices used, 29% of the participants used voice software as well as braille display (as compared to 29% of the population), 16% of study participants used voice software (compared to 21% in the population), and 55% of the participants used magnifying tools such as video magnifiers or software with magnification and screen reading (compared to 51% of the population). In terms of age, 14% of the participants were younger than 35 years of age (compared to 17% of the population), 33% were aged between 36 and 55 years (compared to 23% of the population), 41% were between 56 and 75 years old (compared to 34% of the population), and 13% were 75 years of age and above (compared to 25% of the population).

Procedure

The survey research was commissioned by the Ministry of Social Affairs and Social Services in Israel. The Ethics Committee in the ministry approved the research methods. In order not to expose to the researchers people who did not wish to participate in the study, ministry officials invited potential candidates (people who received assistive technology devices) to participate in the study. Only those individuals who expressed explicit consent were contacted by the researchers. Before the beginning of the interview, participants signed a consent form stressing that they could withdraw from the experiment at any time and that participation was voluntary.

Four interviewers were instructed as to how to evaluate the participants' proficiency, including at least one observation for practice before their first evaluation. In order to maintain a high level of consistency, simulations were conducted among the interviewers until they reached a high correlation between the different estimations.

Each interviewer met each participant at or near his or her home. The interviewer first administered questionnaires to collect information regarding the participant's manner and frequency of computer-based assistive device use, degree of satisfaction with the device, level of quality of life, and sociodemographic background. Next, the interviewer instructed the participant to carry out eight tasks using his or her personal computer and assistive device. The interviewer used an evaluation form to rate the participant's performance on each task. The duration of each meeting was about 45 to 60 minutes.

Research tools

Direct observation and evaluation of computer usage

A research assistant directly observed participants' usage of their own personal computers in order to evaluate their computer usage skills while using the device. This method provided a measurement based not only on the individual's subjective perception of his or her skill level but also an objective assessment from an interviewer. Four of the eight tasks given to the participants involved surfing the Internet; two involved the use of Microsoft Word software; and two involved the use of e-mail.

The interviewer rated the participant's performance on each task by filling out an evaluation form (Scott et al., 2002). The observer evaluated the efficiency and speed with which the participant performed each task by using a 5-point Likert scale (1 = poor performance; 5 = excellent performance).

Questionnaires

Questionnaires were used to collect information about the participant and his or her computer-based assistive device usage habits. The first questionnaire collected the following information: sociodemographic characteristics, state of vision, computer-based assistive device type, and daily browsing duration. In particular, participants were asked how many hours and how many leisure hours a day they spent in front of a computer. In addition, participants were asked to what extent the assistive devices affected their leisure time. The scale ranged from 1 to 5, where 5 was very influential and 1 had a small effect. Also, the Vision-Related Quality of Life Questionnaire (VQOL) ($\alpha = .82$) was administered along with a questionnaire examining the types and frequency of computer usage. This quality-of-life questionnaire was used previously in various studies (Hinds et al., 2003). Participants were also asked to evaluate the amount of time they performed particular tasks (for example, reading and writing e-mail). The scale ranged from 1 to 5, where 5 was at least once a day and 1 was never. In addition, participants were asked a number of questions regarding satisfaction (for instance, Are you satisfied with the assistive technology?). The scale ranged from 1 to 5, where 5 was very much and 1 was very little. Finally, participants were asked to describe at length to the interviewer their notions

Table 1
Frequency of computer use by populations.

Variable	Hours using the computer per day	Hours using the computer per day for leisure	The effect of the computer on leisure time*
Gender			
Men	4.43	2.97	2.14
Women	3.76	3.22	2.24
Vision condition			
Blindness	4.19	3.27	2.14
Limited visual acuity and limited field of view	3.35	2.28	2.19
Limited field of view	5.42	4.83	1.92
Limited visual acuity	2.86	1.87	1.71
Employed			
Yes	5.03	2.58	1.36
No	3.58	3.39	2.18
Device type			
Video magnifier	2.05	1.00	2.57
Voice software	3.63	2.77	2.47
Enlargement software	4.75	3.38	1.56
Video magnifier voice, enlargement	4.00	4.00	2.00
Braille + voice	5.58	4.06	1.56
Enlargement + voice	3.33	3.00	2.50
Video magnifier + enlargement	5.20	3.90	3.20

*The average reflects the effect of the computer on the leisure life of the subject. The scale ranges from 1 to 5, where 5 is very influential, while −1 is small impact.

regarding the performance of their computer-based assistive devices and their satisfaction.

Analysis

The first goal of the analysis was to examine the extent of the use of various technologies. The second goal was to identify the frequency of computer use by populations—in particular, the extent to which the computer was used in the various groups was examined. The third goal was to evaluate the performance levels of participants. Accordingly, a performance level of specific groups of participants was evaluated and the difference across the groups was analyzed using ANOVA tests and a *t*-test. In addition, a goal was to identify participants' frequency of various actions performed with computers and their satisfaction with the technologies. In addition, a regression analysis was carried out to identify which variables were associated with task performance.

Results

Table 1 displays the frequency of computer use according to sociodemographic segments. As can be seen in the table, the majority of participants reported using computers for several hours a day (for an average of four hours daily). A significant proportion of the participants indicated that their computer use is mostly for leisure (an average of three hours daily). The effect of the devices on leisure was usually moderate, with an average of 2.14

Table 2
Evaluation of performance ($N = 63$).*

Variable	*M*	Microsoft Word usage	Internet usage	E-mail usage
All				
M	3.50	3.47	3.42	3.81
SD	0.95	1.22	1.06	1.26
Gender				
Men	3.52	3.64	3.26	3.98
Women	3.48	3.28	3.63	3.62
Vision condition				
Blindness	3.58	3.53	3.60	4.16
Limited visual acuity and limited field of view	3.35	3.66	3.18	3.19
Limited field of view	3.03	2.95	2.67	3.75
Limited visual acuity	3.99	3.13	4.04	4.53
Employed				
Yes	3.60	3.51	3.48	3.76
No	3.45	3.46	3.39	3.86
Age				
22–45	3.15	3.18	2.96	3.41
46–58	3.44	3.62	3.36	3.96
59–68	3.80	3.38	3.70	4.30
69–90	3.59	3.64	3.57	3.68
Years of education				
Less than 12	3.47	3.38	3.54	3.65
12–14	3.63	3.67	3.36	4.22
14–16	3.44	3.52	3.35	3.93
More than 16	3.53	3.50	3.30	3.80
Years of assistive technology usage				
0–3	3.77	3.40	3.80	3.83
3–6	3.68	3.84	3.58	3.89
6–10	3.28	3.52	2.90	3.78
10–40	3.22	3.03	3.41	3.73

*Only 63 respondents took part in the observation. The reasons for not participating were varied, ranging from technical problems with accessibility or computer accessories, or refusal to participate due to unspecified reasons. Ten respondents said they do not use the devices.

for men, and 2.24 for women (where 5.00 is very influential).

Observations

Only 63 of the 96 participants took part in the observation (see Table 2). The reasons for not participating were varied, ranging from an inability to use the device (10 respondents said they did not use the devices), technical problems, or refusal to participate for an unspecified reason. Sociodemographic analysis of the group of users who did not participate in this stage of the study did not disclose a difference between these users and the larger sample in terms of gender, age, nationality, employment status, education level, and years of blindness.

Table 2 displays the interviewer's evaluations of participants' performance on the tasks. For each task, a single performance quality score equal to the mean of

Table 3
Regression model for prediction of quality of performance.

Variable	BETA	*SE*	*B*
Age	.012	.007	.204
Gender			
Education in years	.005	.017	.036*
Employment	−.335	.254	−.170
Quality of life	−.274	.158	−.223

*$p < .05$.

the rating of task execution efficiency and the rating of speed of execution was calculated. As indicated in the table, participants' performances on the tasks were overall quite good (above 3 in most cases). On average, participants achieved moderate to good performance scores for each task (between 3 and 4), according to the interviewer's assessment (overall average of 3.5; maximum rating was 5.0). Table 2 also presents the performance levels of specific groups of participants; no significant differences were found across the groups ($p > .1$ in all cases).

A regression analysis was carried out to identify which variables were associated with task performance (see Table 3). Specifically, the performance quality score served as the dependent variable, and the predictor variables tested were gender, age, duration in years, employment (yes or no), and quality of life. The model is significant and explains 13.1% of the variance (adjusted $R^2 = .131$; $F(5, 59) = 2.926$, $p < .05$). It indicates that quality of life was positively associated ($B = .223$) with performance quality ($p < .1$).

Frequency of various actions performed with the computer

Table 4 indicates that participants used the computer mostly for reading e-mail and surfing the Internet. It illustrates that, on average, they reported that they used the computer to read e-mail and browse the Internet at least once a week.

Participants' satisfaction with their computer-based assistive devices

Table 5 presents participants' mean ratings regarding their satisfaction with their computer-based assistive devices. The table indicates that users' satisfaction was relatively high ($M = 3.98$, $SD = 1.13$). As shown in the table, most participants reported feeling their ability to communicate with people through the computer had improved moderately or to a large extent ($M = 3.11$, $SD = 1.71$). In addition, participants reported feeling their independence had increased moderately following the use of computer-based assistive devices ($M = 3.63$, $SD = 1.41$). Participants also reported feeling that, following the use of computer-based assistive devices, their satisfaction with their leisure time had increased ($M = 3.68$, $SD = 1.34$), and their lives had improved ($M = 3.67$, $SD = 1.19$). Finally, users reported

Table 4
Participants' assessments of the frequency of various actions performed with the computer.

Actions	*M*	*SD*
Read and write e-mail	4.17	1.43
Surf the Internet	4.08	1.44
Write Word documents	3.41	1.40
Listen to music	3.38	1.66
Get news	2.83	1.83
Browse forums	2.51	1.80
Surf entertainment sites	2.39	1.62
Go to the bank site	1.95	1.43
Play games	1.72	1.39
Go to the healthcare services site	1.70	1.02
Read a book online	1.57	1.20

Table 5
Participants' satisfaction with their devices.

Item	*M*	*SD*
Satisfied with the assistive technology	3.98	1.13
Need extra guidance using the assistive technology	2.84	1.58
Need guidance on software	2.56	1.54
Felt their communication with people through computer improved	3.11	1.71
Felt their independence increased following the use of assistive technology	3.63	1.41
Felt their satisfaction with leisure time increased following the use of assistive technology	3.68	1.34
Felt their life improved following the use of assistive technology	3.67	1.19

feeling they needed extra guidance regarding computer-based assistive device usage ($M = 2.84$, $SD = 1.58$), as well as further guidance on computer software usage ($M = 2.56$, $SD = 1.54$).

Discussion

This research sought to investigate the effect of computer-based assistive device use on the quality of life and levels of functioning of individuals with visual impairments in Israel. Our primary focus was on the computer usage skills of visually impaired individuals who were provided with government subsidies for assistive devices. In addition, the frequency of use of computer-based assistive devices was examined, as were users' levels of satisfaction with their devices. The findings suggest that the study participants used their computer-based assistive devices frequently, primarily for leisure. Most participants used computer-based assistive devices daily (four hours of use per day on average, with about three hours of that time devoted to leisure activities) and reported high levels of satisfaction with the devices; a positive influence of the computer-based assistive devices on quality of life and functioning was also indicated.

Uses and skills associated with assistive devices

This study leads to two key observations regarding uses and skills. First, 33 participants did not complete the computer usage tasks for various reasons such as computer failures or lack of knowledge regarding the use of the software used in the tasks. In fact, the findings imply that a significant portion of participants (more than 10%) did not use a computer at all. Second, those participants who did carry out the tasks exhibited, generally, a high level of skill, particularly in the use of e-mail and Microsoft Word software. These results are in line with the questionnaire results (see Table 4), which showed that participants most frequently used their computers for reading and writing e-mail, followed by surfing the Internet, writing documents, listening to music, and reading the news. They were less likely to engage in activities such as surfing on forums, playing games, and browsing entertainment and service websites (such as bank websites and healthcare services), which indicates that performance associated with the use of these applications is expected to be less favorable.

Effects of using assistive devices on quality of life and satisfaction

Most of the participants reported a relatively positive level of quality of life. In addition, to examine the association between quality of life and the use of assistive devices we carried out a statistical analysis and observed a significant correlation between the two variables. A close-to-significant correlation was also observed between the number of hours of use and quality of life. Participants also reported that the use of computer-based assistive devices had an effect on their leisure time, and the majority of individuals indicated that they were satisfied with their devices and felt that their communication capabilities had improved following computer-based assistive device usage. They also reported significant improvement in their lives. For example, they reported that the use of assistive devices increased the degree of satisfaction with their leisure time and their sense of independence. Moreover, most respondents indicated that they felt their devices were easy to use, reliable, useful, user-friendly, and contributed to their quality of life.

It should be noted, however, that a noteworthy percentage of users felt a need for extra guidance in using the devices as well as other computer software. This result is in line with the findings of Wong and Cohen (2011), who point to the need to train visually impaired individuals to use computer-based assistive devices. The study also found that some of the participants had used their own money to acquire computer-based assistive devices that were not currently subsidized by the ministry. Likewise, participants mentioned the need to update the selection of devices that were currently subsidized.

In sum, our findings indicate that computer-based assistive devices have a significant effect on the lives of those who use them. This effect is reflected in the participants' usage of their devices for multiple hours every day, in their usage of many different types of computer applications, in their desire to receive additional training, in their overall satisfaction with their devices, and in their belief that computer-based assistive device usage enhanced various aspects of their quality of life.

Future research

The present study involved 96 participants. Although this sample size is substantially larger than the sample sizes that have been considered thus far in observational studies of practical computer usage skills (no more than 25 participants), it may still be too small to provide an indication of trends in computer usage and connections between usage habits and socioeconomic and other variables. Therefore, future research would benefit from using a larger sample in order to better identify various trends in computer-based assistive device usage across participants with different characteristics. Other limitations of the study are that in many cases no commonly used questionnaires were used. No similar observations were made in past research.

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