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Development of a Smiling Touchscreen Multimedia Program for HRQoL Assessment in Subjects with Varying Levels of Literacy

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ABSTRACT

Objective: As low literacy affects the assessment of health-related quality of life (HRQoL) in several ways (e.g., subject eligibility and cost of administration), better approaches to HRQoL assessment in subjects with varying literacy levels are needed.

Methods: We developed a multimedia touchscreen program (the Smiling Touchscreen, ST) to administer HRQoL instruments to subjects with varying levels of Chinese language and computer literacy, using an iterative process where patients' input on design, clarity of instructions, and user-friendliness were repeatedly gathered and incorporated in development. The ST thus has several user-friendly features for low-literacy subjects (e.g., presentation of individual items using visual and auditory stimuli, voice-text synchronization, and visual analog scale with a touch and drag function), which we evaluated using qualitative and quantitative methods.

Results: The ST was well accepted by subjects (n = 66, 76% female, median [interquartile] age: 49.0 [40.0, 56.0]) with high (n = 43) or low (n = 23) literacy, 98% of whom found it easy or very easy to use, and 85% found the voice-text synchronization feature useful. In low-literacy subjects without computer experience (30%), none reported any difficulties using the ST. The median (interquartile) time spent to complete the ST (four Instruction and Practice screens, 24 questions, one visual analog scale) for high- and low-literacy groups was 13.9 (9.6, 23.9) and 23.2 (15.8, 26.5) minutes, respectively. Among subjects expressing a preference (n = 47), 21 (47%) favored the ST over interviewer- or self-administration.

Conclusion: The ST is well accepted by subjects with varying literacy levels, including those without computer experience. It is thus a promising new approach for HRQoL assessment among subjects with varying literacy levels.

Keywords: computers, data collection, health surveys, literacy, quality of life, rheumatology.

Introduction

There is a strong association between low literacy (both functional and health literacy) and poor health outcomes [1,2]. Low literacy also influences patients' ability to make informed decisions [3], contributes to poor patient–physician communication [4,5], and is associated with poor health-promoting behaviors (e.g., a low cancer screening rate) [6]. In several studies, the association between low literacy and poor health outcomes persisted even after adjusting for demographic and socioeconomic factors [1,2], thus suggesting that low literacy itself is a concern, rather than merely being a marker for low socioeconomic status.

Low literacy is a major issue worldwide. In 2000, the United Nations estimated that 20% of the world adult population aged 15 years and above (approximately 860 million people) were illiterate [7]. About two-thirds of people with low literacy live in India, China, Pakistan, and Bangladesh, four of the world's most populous countries [7]. The problem with low literacy is not confined to developing countries: the United States National Adult Literacy Survey (NALS) reported that 40 million adults are functioning at the lowest level of reading, writing, and quantitative literacy [8].

The problem of low literacy is particularly acute among the elderly, who are also more likely to suffer from chronic medical conditions. In the same NALS study, 71% (or 29 million) adults aged 60 years and above performed at the two lowest levels (out of five) of literacy [8]. Older adults are thus in a disadvantaged position in medical situations, where a high level of literacy is required in navigating the health-care system (e.g., providing informed consent or understanding medication prescriptions). It is not surprising that low literacy among the elderly has been associated with lower use of preventive health services [9], higher risks of hospital admissions [10], and poorer disease knowl-

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edge [11] with the exception of the use of outpatient health services [12].

Health-related quality of life (HRQoL) is increasingly being recognized as an important dimension of health outcome in addition to the traditional measures of mortality, such as hospital admissions and length of hospitalization [13]. Low literacy affects the administration of HRQoL measures in several ways: 1) self-administration is not feasible in subjects with very low levels of literacy; 2) quality of responses (i.e., the degree to which a question is understood) may be influenced by literacy level; and 3) participation rates may be lower because of a reluctance to reveal a low literacy level. Interviewer-administration of HRQoL measures has been used in subjects with low levels of literacy, but is not ideal for several reasons. It is often expensive because of the cost of hiring interviewers fluent in a given language, time-consuming, and subject to interinterviewer variability because of variability in the presentation of the instrument by different interviewers, and poor cooperation if questions are sensitive (e.g., pertaining to sexual functioning). Additionally, data derived from self- and interviewer-administration differ systematically and thus should not be combined [14–16]. These problems are multiplied if subjects from multiple language groups are being studied, as is often the case in the increasingly multicultural sociocultural contexts seen in many countries.

The ideal mode of administering HRQoL instruments would work equally well among subjects with any level of literacy, would provide an identical presentation of the instrument, thus eliminating interinterviewer variability and would be relatively inexpensive to administer. In this article, we report the development of the Smiling Touchscreen (ST)—a touchscreen-based multimedia computer program with audiovisual playback—which has features of the ideal mode of administration mentioned above. It provides an identical stimulus to all subjects, and could potentially be used by subjects with any level of literacy because questions are presented using synchronized visual and audio cues. It also allows subjects to complete the survey privately, which has been shown to be helpful in eliciting answers to questions that are potentially sensitive [17–19]. Touchscreen-based multimedia computer programs have several additional advantages including data reporting in real time, thus facilitating the utilization of these information in routine clinical practice [20]; high acceptance by both patients and clinic staff members, including those who have never used a computer before [21–23]; high agreement between paper and electronic versions of the questionnaires [24,25] and reduced stigma associated with low literacy because subjects do not need to reveal their level of literacy. Additionally, touchscreen-based multimedia computer programs have previously been shown to be effective for delivering patient education materials [26,27].

Methods

Key Features of the Smiling Touchscreen

We developed a multimedia touchscreen program (the Smiling Touchscreen) for use among subjects with varying levels of language and computer literacy to address the limitations of self- and interviewer-administration of HRQoL measures. We chose to develop the program in the Chinese language, the most commonly spoken first language worldwide (used by more than 1 billion people) and in Singapore [28]. We used an iterative process of discussion among the authors followed by testing in convenience samples of outpatients at a Rheumatology and Immunology Clinic (see concept testing) for this Institutional Review Board approved study. The ST includes several features to assist subjects with low literacy. First, each question is presented individually on a 14″ LCD touchscreen monitor using both visual and auditory stimuli (a video clip of an interviewer reading out the question, with accompanying written text). Second, the text changes color in synchrony with the audiovisual playback as it is read to the subject, allowing subjects with low reading literacy to follow the audiovisual playback with relative ease. Third, a visual analog scale (VAS) using a touch and drag function (with "plus" and "minus" buttons for fine adjustment) was used so that subjects could complete a VAS on the screen. Other features of the program included: 1) introductory screens explaining the general features of the program and navigation buttons, with practice questions for subjects to familiarize themselves with the program; 2) audiovisual playback at three different speeds (fast, normal, and slow) to suit different literacy levels; 3) separate replay buttons for the question stem and individual response options so that the subjects could replay any part of the question; 4) an "audit trail" to help identify problematic items by monitoring the amount of time spent on each item, the number of times the repeat button was used, and the number and sequence of changes made for each item; 5) avoiding red and green so that color-blind subjects could use the program; and 6) entry of responses at any time (i.e., not requiring playback of the entire video clip) to accommodate subjects with higher literacy levels.

Development Process

Concept testing. Concept testing was carried out iteratively to devise a user-friendly format for the ST. A graphic designer created two sets of screenshots based on input from the study team. These sets of screenshots were shown to a convenience sample of subjects to obtain feedback on the layout of the video image, text and

Figure 1 Screenshot of the Smiling Touchscreen.

buttons, font size, video screen size, and color scheme. This feedback was incorporated into a second, revised set of screenshots, which were shown to a second convenience sample of subjects to obtain more feedback, based on which the final format was decided (Fig. 1).

Development and testing. This iterative process aimed to obtain feedback on the clarity of instructions provided at demonstration screens, as well as the user-friendliness of the program. Based on feedback gathered from concept testing, we produced a reduced version of the ST with eight screens (one welcome screen, two demonstration screens and five screens with sample items from the EQ-5D [29] and the Health Utilities Index 15Q (HUI-15Q) [30], two widely used HRQoL questionnaires). This reduced version was tested in subjects with varying levels of literacy. Literacy was assessed by asking subjects to report on three separate horizontal VAS scales (score range: 0–100, 10-point interval), their ability to read a Chinese newspaper, understand a Chinese radio program, and write a letter of 50 words in Chinese. Subjects' feedback was consolidated to inform the production of full version, which comprised 31 screens (one welcome screen, two demonstration screens, two practice screens, 24 screens with questions assessing HRQoL [EQ-5D [29], HUI-15Q [30], and Family Functioning Measure [31]], one VAS, and one concluding screen). The full version was tested in a convenience sample of Chinese-speaking outpatients seen at the same clinic who fulfilled the following inclusion criteria: age above 18 years, ability to speak Chinese, and ability to complete the survey. Exclusion criteria were inability to speak Chinese and cognitive impairment. Subjects were invited to complete the ST in a room in the presence of a facilitator, and were then interviewed to obtain sociodemographic information and the feedback on the ST using a structured interview form. Self-reported ability (on a VAS, score range: 0–100, 10-point interval) to use a computer to surf the Internet and previous experience with computers were also assessed. Facilitators for the ST, trained in interview techniques and to demonstrate the use of the ST to subjects who were unfamiliar with touchscreens/computers, were asked to assess the level of difficulty experienced by the subjects with the ST and the amount of help they provided the subjects.

Statistical Analyses

Nonparametric tests of two groups were performed using Mann–Whitney tests. Bivariate tabular analyses were performed using chi-squared tests. All statistical analyses were performed using STATA Intercooled v.8 software (STATA Corporation, College Station, TX, USA, 2003).

Results

Concept Testing

We showed sample screenshots of different layouts for the program using a LCD screen to seven patients (all female: one young, five middle-aged, and one elderly) seen for routine outpatient care. These subjects preferred the text box to be presented using a white font against a dark colored background, and the video to be displayed at the top right corner of the screen. Nevertheless, they had no preference for the position of the response buttons. This feedback was incorporated into the second, revised set of screenshots which were shown to another eight patients (one middle-aged male, three young females, two middle-aged females, and two elderly females), whose input was incorporated into the design of the final format.

Development and Testing: Reduced Version

We divided the subjects into low- (n = 12, 75% female) and high-literacy (n = 19, 63% female) groups using a cutoff point of 50 on self-reported VAS scores for ability to read a Chinese newspaper. This cutoff was chosen as it corresponded to the natural division within this sample (Fig. 2), and also as a pragmatic approach to determine self-reported literacy as there were no validated tests of literacy available in the study population when this study was performed. The two groups were similar in terms of median age (low vs. high literacy, 46.5 vs. 51.5 years, $P = 0.72$), gender (females 75% vs. 63%, $P = 0.49$), and computer literacy (median VAS scores 70.0 vs. 52.5 [0–100 scale]), although the high-literacy group reported significantly higher median VAS scores for verbal comprehension (90.0 vs. 60.0, $P < 0.001$) and writing literacy (60.0 vs. 0, $P < 0.001$). In both groups, the majority of subjects preferred the normal audiovisual playback speed. All subjects felt that instructions were clear and understandable. The main area of feedback pertained to the VAS, based on which a "touch and drag" function was added to allow subjects to drag the cursor to the approximate desired position and to make fine adjustments (in units of one point on the VAS) using the "plus" or "minus" buttons. Other revisions to the reduced version were minor and were mainly cosmetic (e.g., choice of colors, positions of buttons, etc.).

Development and Testing: Full Version

We again divided the subjects into low- (n = 23) and high-literacy (n = 43) groups. Subjects in both groups were similar in terms of age ($P = 0.90$), (unexpectedly, in) years of education completed ($P = 0.99$), and computer literacy ($P = 0.33$), with a trend toward more male subjects in the low-literacy group ($P = 0.20$, Table 1), although the high-literacy group again reported significantly higher median VAS scores for verbal comprehension ($P < 0.001$) and writing literacy ($P < 0.001$), and required less time to complete the ST ($P = 0.017$, Table 2). Thirty percent of the subjects in both groups had never used a computer before, while approximately half of the subjects used a computer daily. There were no missing data for HRQoL instruments, by virtue of the design of the program.

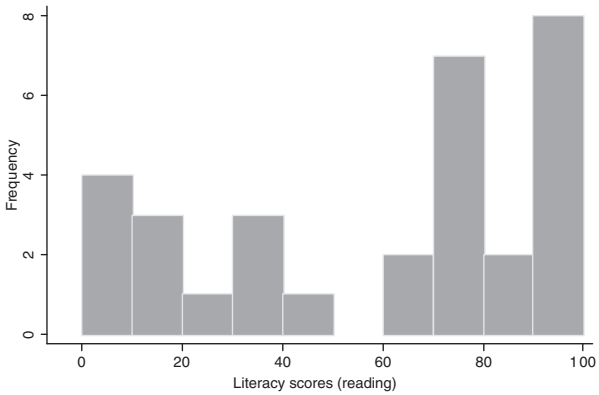

Figure 2 Development and testing (reduced version, n = 31): frequency distribution of self-reported ability to read Chinese newspaper on a visual analogue scale (range: 0–100, 10-point interval).

All subjects except one in the high-literacy group felt that the touchscreen monitor was either easy or very easy to use. This lone subject felt that the touchscreen monitor was neither easy nor difficult to use. The median (interquartile range) time spent to complete the ST (four Instruction and Practice screens, 24 questions, one VAS) for high- and low-literacy groups was 13.9 (9.6–23.9) and 23.2 (15.8–26.5) minutes, respectively ($P = 0.017$). Nineteen subjects (29%) did not express a preference for any mode of administration. Among subjects expressing a preference (n = 47,

Table 1 Characteristics of study subjects

	N (%), unless stated		
	Subjects with high reading literacy (n = 43)	Subjects with low reading literacy (n = 23)	*P*-value
No. of patients recruited	48	28	
No. of premature study terminations	4	3	
No. with missing demographic data	1	2	
Final no. analyzed	43	23	
Female (n, %)	35 (81)	15 (65)	0.20
Age in years, median (interquartile range)	49.0 (40.0, 56.0)	49.0 (34.0, 57.0)	0.90
Years of education (n, %)			0.99
≤6	9 (21)	5 (22)	
7–10	18 (42)	10 (43)	
≥11	16 (37)	8 (35)	
Self-reported Chinese literacy, median (interquartile range)			
Reading	80.0 (70.0, 100)	20.0 (0, 50.0)	<0.001
Verbal comprehension	90.0 (80.0, 100)	60.0 (50.0, 80.0)	<0.001
Writing	60.0 (50.0, 80.0)	0 (0, 40.0)	<0.001
Computer	70.0 (0.0, 90.0)	80.0 (0, 100)	0.33

Table 2 Subjects' assessment of the Smiling Touchscreen

	N (%)		
	Subjects with high reading literacy (n = 43)	Subjects with low reading literacy (n = 23)	*P*-value
Time spent on survey (minute), median (interquartile range)	13.9 (9.6, 23.9)	23.2 (15.8, 26.5)	0.017
Frequency of computer usage (n, %)			0.75
Never	13 (30)	7 (30)	
Few times a year	3 (7)	1 (4)	
At least once a month	2 (5)	1 (4)	
At least once a week	6 (14)	1 (4)	
Almost every day	19 (44)	13 (58)	
Ease of use of touchscreen program (n, %)			0.21
Very easy	21 (49)	14 (61)	
Easy	22 (51)	8 (36)	
Neither easy nor difficult	0 (0)	1 (4)	
Difficult	0 (0)	0 (0)	
Very difficult	0 (0)	0 (0)	
Preferred mode of administration (n, %)			0.32
Computer	11 (26)	10 (44)	
Interviewer	7 (16)	6 (26)	
Self	6 (14)	2 (9)	
Computer or interview	2 (5)	1 (4)	
Computer or self	1 (2)	1 (4)	
No preference	16 (37)	3 (13)	
Usefulness of voice-text synchronization (n, %)			0.91
Useful	36 (84)	20 (87)	
Not useful	3 (7)	1 (4)	
No comments	4 (9)	2 (9)	
Selected video speed (n, %)			0.14
Normal	38 (88)	19 (82)	
Fast	5 (12)	2 (9)	
Slow	0 (0)	2 (9)	
Preferred video speed (n, %)			0.14
Normal	34 (79)	17 (74)	
Fast	9 (21)	4 (17)	
Slow	0 (0)	2 (9)	
Problems completing the survey items (n, %)			0.031
No	40 (93)	17 (74)	
Yes	3 (7)	6 (26)	
Facilitators' assessment of the level of difficulty experienced by subjects with the computer (n, %)			0.48
No difficulty at all	36 (84)	20 (87)	
A little difficulty	4 (9)	2 (9)	
A lot of difficulty	1 (2)	0 (0)	
Could not understand at all	0 (0)	1 (4)	
No comments	2 (5)	0 (0)	
Facilitators' assessment of the amount of help they provided the subjects (n, %)			0.27
Did not need any help	32 (74)	15 (65)	
Needed a little help	9 (21)	6 (27)	
Needed a lot of help	0 (0)	1 (4)	
Needed continuous help	0 (0)	1 (4)	
No comments	2 (5)	0 (0)	

71%), 21 favored the ST, 13 favored interviewer, eight favored self-administration, three favored the ST or interviewer, and two favored the ST or self-administration. More than 80% of the subjects in both groups felt that the voice-text synchronization feature was useful. All subjects (n = 60, 91%) who listened to the instructions at the demonstration screen felt that these were clearly given. Only one subject felt that some items in the questionnaire made her feel embarrassed. Generally, the computerized software program was well accepted by patients and no further refinements were deemed necessary.

Facilitators reported that more than 95% of the subjects in both groups had no or only a little difficulty using the ST. They did not need to provide any help to use the ST for more than 65% of the subjects. Only two subjects (9%) in the low-literacy group (and no subjects in the high-literacy group) required a lot or continuous help with using the ST.

Discussion

We developed the ST—a touchscreen-based multimedia computer program with audiovisual playback—to

address the problems of varying levels of literacy and the limitations of self- and interviewer-administration of surveys and HRQoL measures. The ST was well accepted by subjects with low or high levels of literacy, the majority of whom found it easy to use. To the best of our knowledge, this represents one of the first attempts to address the issues of literacy in concert with overcoming the limitations of self- and interviewer-administered surveys. We also compared the ST with interviewer administration in a pilot randomized clinical trial in 138 patients, and found that in both ST and interviewer administrations, 1) time taken to complete a questionnaire containing 5 HRQoL instruments (EQ-5D, EQ-VAS, Health Utilities Index Mark 2 and 3 and FFM) was similar for both modes of administration and 2) mean HRQoL scores were similar for 4 of 5 HRQoL instruments [33]. The "talking touchscreen" developed by Hahn et al. [1] represents one of perhaps several touchscreen-based programs with an audio component. We believe that such touchscreen-based programs may be further improved by adding a visual component, which confers several potential advantages. By including a smiling face on the screen, the ST is likely to be more "user-friendly" and appealing [32], especially for noncomputer users. Also, it simulates an interview setting (by providing similar stimulus), thus allowing for more meaningful comparisons between the two modes of administration. In addition, the voice-text synchronization feature, found to be useful by more than 80% of the subjects in both high- and low-literacy groups in this study, makes it easier for the subjects, especially for those with low literacy, to follow the questions.

In general, the ST was well received by subjects in both high- and low-literacy groups. One-third of the subjects with low literacy reported that they had never used a computer before, but none of these subjects reported any difficulties using the touchscreen monitor. Some subjects who were initially apprehensive about using the computer reported that their apprehension was unfounded after attempting the practice screens. One subject commented that, "the system was 'not bad.' It allows us to understand our health more." On the user-friendliness of the ST, one subject in the high-literacy group commented that, "(this is) very enjoyable and interesting. (It is also) simple to use. (I can) while away my time while waiting to see the doctor." Another subject in the high-literacy group commented that, "the computer program is very good. It is a new and interesting approach. (It) allows a patient to complete the survey in privacy. If possible, please let patients install the program at home and complete it from home." The main negative comment received from subjects was that the survey was too lengthy. Facilitators' comments on the ST were also favorable, with most subjects not having any difficulties with the program and not requiring any help. That up to a third of subjects with low literacy required at least some help in using the ST deserves attention. Nevertheless, as only two subjects (9%) required a lot of or continuous help, the ST is less likely to adversely affect workflow in a clinical setting. In this study, performed in an outpatient Rheumatology and Immunology clinic, we did not encounter significant disruptions to workflow. Of note, only three patients (5%) had to terminate the study prematurely so as to avoid disruptions to the clinic workflow.

As the ST is generally well-accepted and can be completed in a reasonable time, it can potentially be incorporated into routine clinical assessment. That the majority of subjects did not require help to complete the ST was encouraging, as staff time could then be better utilized in other value-added activities rather than in questionnaire administration. Further, the ST could enhance routine clinical care and reduce costs by being made available in several languages. Obtaining similar results using interviewer-administration would be costly and logistically difficult, as it would require staff fluent in these languages to be present during patient visits. The ST may also be used for purposes other than HRQoL assessment, for example, in patient education, obtaining a patient history or food diary, etc. In the long run, the cost of developing and implementing the ST may therefore be lower than the cost of engaging interviewers for these tasks.

Conclusion

The ST appears to have significant potential to both overcome the limitations of self- and interviewer-administered surveys, enumerated in the introduction, as well as to provide a single mode of administration which can be used for all subjects, regardless of their level of literacy. Its usefulness as an alternative to interviewer-administration relies on its ability to consistently provide an identical presentation of questions asked, thus eliminating interinterviewer variability. We have demonstrated in this study that the ST was well accepted and easily completed by subjects with low levels of literacy who would not be able to self-administer questionnaires. The ST is thus a potentially useful advance in administering HRQoL instruments among subjects with varying levels of literacy. Further work, currently in progress, is needed to determine whether there are systematic differences in scores, and variability in scores, obtained using the ST versus interviewer-administration, and to confirm the results of this study in different languages and sociocultural contexts.

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