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Designing websites for persons with cognitive deficits: Design and usability of a psychoeducational intervention for persons with severe mental illness.

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Abstract

The purpose of this study was to develop an understanding of the design elements that influence the ability of persons with severe mental illness (SMI) and cognitive deficits to use a website, and to use this knowledge to design a web-based telehealth application to deliver a psychoeducation program to persons with schizophrenia and their families. Usability testing was conducted with 98 persons with SMI. First, individual website design elements were tested. Based on these results, theoretical website design models were used to create several alternative websites. These designs were tested for their ability to facilitate use by persons with SMI. The final website design is presented. The results indicate that commonly prescribed design models and guidelines produce websites that are poorly suited and confusing to persons with SMI. Our findings suggest an alternative model that should be considered when designing websites and other telehealth

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interventions for this population. Implications for future studies addressing the characteristics of accessible designs for persons with SMI and cognitive deficits are discussed.

Keywords

cognitive deficits; accessibility; telehealth; severe mental illness; website

Increasingly, patients and families are using the Internet for education, support, self-help management, and to learn how to cope with serious illnesses (Cashen et al., 2002). A 2005 study found that 8 out of 10 (79%) American adults use the Internet to find information about medical problems and 23% to locate information about mental health issues (Fox, 2005). In recognition of its potential, the President's New Freedom Commission on Mental Health (The President's New Freedom Commission on Mental Health, 2003) has established as one of its primary goals the use of advanced communication technology to improve consumers' and families' access to information, professionals, treatments and support services. However, the use of telecommunications technologies, such as websites, can involve complex cognitive activities, which may limit effective use by persons with cognitive deficits, such as those associated with severe mental illness (SMI; Stephanidis, 2000).

Research indicates that the usability of a website is partly influenced by a user's ability to create a "mental model" of the site (Dalal, Quible, & Wyatt, 2000; Glenberg & Langston, 1992). A mental model is a cognitive representation or schema of the organization of information in a website that is the product of an iterative process that reflects a user's cumulative understanding of a site and is updated as learning occurs (Dalal et al., 2000). An implication of this framework is that when a user is unable to develop a mental model of a site or creates an inaccurate model, either due to the design of a site and/or due to limitations in his or her cognitive functioning, he or she may have difficulty using the site effectively and may not be able to learn how the site is organized even after repeated usage.

The cognitive abilities that have been found to be relevant to website use include spatial ability when searching for information (Chen & Rada, 1996; Hook, Sjolinder, & Dahlback, 1996; McGrath, 1992; Vicente, Hayes, & Williges, 1987), and verbal ability when reading is required to complete a task (Vicente et al., 1987). In addition, work on human information processing indicates that the following three cognitive functions are likely to play important roles in the use of websites due to the types of tasks in which they are involved: a) executive functions, which are involved in searching, problem solving, and task sequencing (Green, 1998); b) working memory, which includes the visuospatial sketchpad and is involved in retaining and recalling information (Sharma & Harvey, 2000), such as executing step-by-step sequences (Broderbund Software, 1997; Vanderheiden, 1998), making category assignments and recognitions (Levine, Horstmann, & Kirsch, 1992; Trace Research and Development Center, 1996), interpreting abstract concepts (Trace Research and Development Center, 1996), and creating of mental models (Baddeley, 1986); and c) sustained attention, which involves focusing attention on a single task (Miller & Schreve, 1994; Vanderheiden, 1998) and ignoring distractions.

Cognitive Deficits Associated With Severe Mental Illness

Persons with SMI and particularly individuals with schizophrenia have been found to have neurocognitive deficits in several domains, involving perception, attention, and the semantic memory system, which is responsible for knowledge of relationships between objects (Sharma & Harvey, 2000). Impairments have been found in the working memory system, particularly as related to spatial abilities and language (Green, 1998), and episodic memory, which is involved in the ability to learn and recall information from previous experience (Goldberg, Weinberger, Pliskin, Berman, & Podd, 1989; Koh, 1978; Levin, Yurgelun-Todd, & Craft, 1989; Schwartz, Rosse, & Deutsch, 1992; Sharma & Harvey, 2000; Tulving, 1983; Yurgelun-Todd & Waternaux, 1991). Deficits have been found in visual-spatial processing, psychomotor skills, and executive functioning, which encompasses the cognitive abilities necessary for complex goal-directed behavior, planning, problem solving, task sequencing, concept formation, alternating between two or more tasks, and anticipating outcomes (Aleman, Hijman, de Haan, & Kahn, 1999; Edwards, 1995; Heinrichs & Zakzanis, 1998; Palmer & Heaton, 2000; Pantelis et al., 1997; Sharma & Harvey, 2000). Investigators have also found deficits in vigilance, or the ability to sustain attention (Green, 1998), and in general intelligence (Aylward, Walker, & Bettes, 1984; Baddeley, 1986; Green, 1996; Heinrichs & Zakzanis, 1998). Deficits exist in information processing, including the use of erroneous logic (Arieti, 1955; Von Domarus, 1944), overinclusive thinking (Cameron, 1938), and the propensity for personal meanings to dominate interpretation of themes and categories (Steffy, 1993).

A Standard Website Design Model

Published guidelines present a common model of effective website design (Federal Register, 2000; Francik, Levine, & Tremain, 1999; IBM, 2001; Koyani, Bailey, & Nall, 2003; Microsoft, 2005; Sun, 2005; Trace Research and Development Center, 1996; World Wide Web Consortium [W3C], 1999; W3C, 2004b), which could be described as a “strict,” or even a stark modular, abstract design. We previously employed such a design successfully as the foundation for a website intervention for wives of husbands with traumatic brain injury (TBI; Rotondi, Sinkule, & Spring, 2005). This model is encapsulated by the following design characteristics. First, the contents of the website are organized into a small number of primary modules, which are discrete conceptual groupings of content (e.g., a library). This keeps the number of modules to a minimum. Each primary module is organized with its own virtual area in the website hierarchy. Modules of a website in this model are analogous to chapters in a book or branches on a tree. Second, the homepage has a link to only these highest-level modules. In this sense, the homepage is analogous to a table of contents in a book, and simply functions as a gateway, which contains little more than links to these chapters. Third, succinct and, thus, abstract but meaningful link labels are employed, usually one or two words in length. Fourth, the content on a given page is organized into discrete areas. Each area of a page contains content with a common theme (e.g., all search functions are together in one area of the page, “news stories” in another area). Fifth, navigation is implemented using one or two dimensions. The navigational links to the primary modules are grouped together in a consistent and prominent place on each page of a website. For example, they often appear across the top of a page in a “toolbar.” This constant

This model of website design, which was the basis of our prior TBI website, the Family Care Network (Rotondi, Sinkule, et al., 2005), is illustrated by the University of Pittsburgh's website (i.e., <http://www.pitt.edu>; accessed 7/2005). The University homepage has along the left side 15 links (e.g., "About Pitt," "Admissions," "Academics") and very little prose text. When a user clicks on one of the highest-level content area links on a homepage of this design, he or she is taken to the section of the website that is devoted to that specific topic. For example, if one clicked on the link "Academics" from the University of Pittsburgh's homepage, he or she would be taken to a page of more than 130 links to the departments and academic programs of the University. This page has only three headings (seven words total) that are not links and contains only one sentence, which is not a link. Each of the links is presented simply as a link, which is typically one or two words long, with no additional explanation. The features of a strict modular abstract design allow the homepage, as well as subsequent navigational pages, to be relatively uncluttered, focused on the single task of navigating to sections of a website and thus allowing users to move step-by-step to resources of interest.

One of the difficulties in designing a website for persons with SMI and others with cognitive deficits is that there has been no usability research on the types of designs that are effective for such persons (Bulger, 2002). Usability testing involves observing how users perform tasks and assessing quantitative user performance (e.g., task completion time, number of

incorrect pathways chosen, number of times failed to find content; Kim, Brock, Orkand, & Astion, 2001; Krug, 2002). Virtually all published website usability studies have focused on people with standard information-processing abilities, including persons with physical and sensory disabilities (Edwards, 1995). As a result, so have published website design guidelines. We conducted a comprehensive literature search of medical, engineering, information science, and design databases from 1966 through August 5, 2005, and conducted an extensive Internet search (see Appendix). We did not identify any studies that assessed quantitative website usability performance with persons with SMI or any research-based web design guidelines. Though several studies have assessed the effects of computer application use by persons with SMI (Ahmed, Bayog, & Boisvert, 1997; Chinman, Young, Schell, Hassell, & Mintz, 2004; Jones et al., 2001; Madoff, Pristach, Smith, & Pristach, 1996; Rosenman, Levings, & Korten, 1997; Weber, Fritze, Schneider, Simminger, & Maurer, 1998), we found only one usability evaluation specific to SMI, which had users “think aloud” while looking over a website (Farrell, Mahone, & Guilbaud, 2004), but included no quantitative performance assessments or recommendations to improve website design. A second study, a Master’s thesis, assessed quantitative usability performance, but with five persons having a mental disorder (generalized anxiety or panic disorder; Bulger, 2002).

Although there are several prominent published guidelines for designing websites, as mentioned above, due to the absence of experimental studies with persons with cognitive deficits, in general, and persons who have SMI, in particular, research-based guidelines have not been published for, nor have the existing guidelines been tested on, users who have SMI and/or cognitive deficits. As a result, the recommendations generally are too nonspecific to provide adequate guidance for designing websites that meet the specific needs of persons with SMI. For example, regarding the labeling of a website’s hyperlinks, the guidelines recently released by the US Department of Health and Human Services state: “Use link labels and concepts that are meaningful, understandable, and easily differentiated by users rather than designers” (Koyani et al., 2003, p. 84). This is certainly appropriate for all types of users; however, our research indicates that quite long, or *explicit* labels (e.g., eight or more words in length), rather than the very common one- or two-word succinct labels (i.e., *inferential* labels), are more appropriate for persons with SMI. Thus, though this recommendation may apply generally to all users, due to a lack of research, the technical specifics needed to actually guide the design of websites for persons with SMI are missing, and the data we present in this paper indicate that the design solutions for persons with SMI may be quite distinct.

Six of the guidelines identified in our literature search did mention cognitive “disabilities” or “impairments” (Francik et al., 1999; IBM, 2001; Microsoft, 2005; Trace Research and Development Center, 1996; W3C, 1999; W3C, 2004b). However, the design recommendations for persons with cognitive deficits were based on the authors’ knowledge and experience with persons who had physical and sensory disabilities and did not offer specific or adequate guidance for SMI populations. For example, the guidelines produced by IBM (2000) recommended “describing your users’ range of abilities and accounting for vision, hearing, mobility, or cognitive impairments,” and “designing your website to be

accessible to a full range of users.” (p. 7) It did not offer any specific guidance for designing a website that could be used by persons with SMI. None of the guidelines mentioned mental illness. Two of the guidelines that mentioned cognitive deficits identified the groups of persons who have cognitive deficits, which included Alzheimer’s disease, attention deficit disorder, dementia, learning disability, dyslexia, epilepsy, traumatic brain injury, and mental retardation, but did not include SMI (Francik et al., 1999; Trace Research and Development Center, 1996). We did find one supporting document produced by W3C (2004a), which mentioned “mental health disabilities.” It provided the following anemic coverage for how to address this group’s design needs: “Individuals with mental or emotional disabilities may have difficulty with blurred vision or hand tremors due to side effects from medications. Barriers can include: distracting visual or audio elements that cannot easily be turned off; web pages with absolute font sizes that do not enlarge easily.” (p. 11)

The Need to Develop Design Models That Match Users’ Capabilities

Findings from usability studies of persons with physical disabilities, data on the cognitive deficits of persons with SMI, and our findings reported below suggest that people with different types of functional limitations (e.g., vision, hearing, cognition) have different website design needs. To identify these needs and determine the best way to meet them, usability studies must be performed with persons who have a particular condition. Studies of ways to improve the accessibility of websites for persons with physical and sensory disabilities have found that one design cannot meet the needs of persons with all types of impairments but rather, that those with different limitations require different designs (BBC, 2003). This has also been found in studies of persons who perform in the normal range of cognitive function. Interfaces that are redesigned can decrease the differences in performance between subjects with low versus high spatial ability (e.g., in Benyon’s study (1993) a 35% difference in time to carry out tasks was reduced to only 1% by an interface redesign; Stanney & Salvendy, 1992).

Given the nature of the mental tasks required to use a website and the cognitive deficits associated with SMI, it is reasonable to assume that persons with SMI will have unique website design needs (Stephanidis, 2000). The lack of empirical research with individuals with SMI raises questions about the applicability of current models of web-interface design and published usability standards. In order for persons with SMI to not be left behind or left out of technological transformations in health care delivery and as behavioral health care has moved to a model with greater focus on consumer input, research must be conducted to understand the limits of current interface designs and develop appropriate presentations for persons with SMI and others with cognitive deficits. In this article, we report the results of a quantitative usability evaluation study that was part of the development activities of a treatment website designed for persons with SMI. The treatment website was very frequently used by participants with SMI, to an extent that surprised even the investigators (to wit, 15 users with schizophrenia accumulated >17,000 “page hits” or page views in the first three months of website use), and had positive effects on outcomes (Rotondi, Haas, et al., 2005). As a result of these observations, we reviewed our website and evaluation data to identify characteristics that might account for its highly effective design for persons with cognitive deficits. Given the lack of applicable design models and experimental design work

in published mental health literature, adequate detail is provided to guide others with less background in human computer interaction studies and usability testing. The results of this work provide a conceptual design model for interface design and serves as an example for developing mental health websites for persons with SMI.

Method

Recruitment of Participants

Participants were recruited from August through November 2002, from six Psychiatric Rehabilitation Centers in the Pittsburgh, Pennsylvania area. In order to receive services from a Psychiatric Rehabilitation Center, a recipient had to have been diagnosed with an SMI (schizophrenia, schizoaffective disorder, major depressive disorder, or bipolar disorder), be an active consumer at an associated clinic, and have services paid for by insurance. For many of the users of these Centers, a county agency was their insurer, which meant that they were designated as having low income. Staff told clients about the study and notices were posted at Centers. Staff was told that we did not want them to steer higher-functioning clients to the study, but rather that we were most interested in developing a website that could be used by all SMI clients, including very ill clients. Of the 98 participants, 89% were female; 61% were between the ages of 31 and 50; and 38% were African American (see Table 1). Overall, the clients at the Centers we recruited from were 60% female, and 50% African American.

Rating of Participants' Levels of Functioning

We used a five category rating system based on the Global Assessment Scale (GAS; Endicott, Spitzer, Fleiss, & Cohen, 1976, see Table 1), where each category corresponded to 2 of the 10-point ranges or 20 points of the 100-point range (e.g., 1–20, 21–40). The purpose was to provide a relatively global measure of participants' functioning.

Training of Usability Testers

All of the usability testers had been formally trained and had experience administering several clinical assessment scales, including the Scale for the Assessment of Negative Symptoms (SANS) and the Scale for the Assessment of Positive Symptoms (SAPS; Andreasen, 1990), the Brief Psychiatric Rating Scale (BPRS; Overall & Gorham, 1962), Clinical Global Impressions (CGI; Guy, 1976), and the GAS. Training to conduct usability testing was specific to each task. Testers were given instruction on conducting each task and then practiced the task with volunteers. Group debriefing sessions were used to clarify procedures and develop consistency across testers for each task.

Usability Testing

Based on extensive needs assessments (Rotondi, Haas, et al., 2005), involving professionals, family members, and over 100 persons with SMI, the main contents of the website were selected. The next step was to design a website to present these contents. This was accomplished via a sequence of usability tasks. The early tasks developed the foundations for the website by appraising vocabulary, hyperlink labels, and titles for the content. Latter tasks were used to design an appropriate navigational framework and organizational

hierarchy for the website, using results from earlier tasks. During all tests, the test administrators recorded observations (e.g., comments, difficulties, things that were confusing). Usability testing proceeded using an inductive reasoning process commonly used in qualitative data collection that employed constant comparative analysis methods of concurrent data, and these analyses were used to inform subsequent collection and analysis (Glaser & Strauss, 1967; Miles & Huberman, 1994). The results from a particular task were collected and analyzed and then used to inform the design of the next task in the sequence; however, testing for each task was performed iteratively. As information was obtained that could be used to modify a task, it was modified (e.g., replacing unfamiliar vocabulary and concepts with those more familiar) and then subsequent testing for that task proceeded.

Each participant was used for only one task in the sequence for two reasons. First, a certain amount of learning and familiarity with the contents and design would occur as a result of participating in a usability task. We wanted to design a website that was relatively intuitive. Having participants who did not have experience with prior testing was done to emphasize intuitive characteristics of the design. Second, this allowed data to be collected from a larger sample and, thus, captured more of the possible variation in responses. As a result, each participant performed one of the six tasks.

Usability Testing Phase One: Comprehension and Organization of Information

Two of the goals for the usability activities were to make the terminology and organizational concepts used in the website user-based, as opposed to web designer- or mental health professional-derived. We learned in previous website intervention work that there can be critical differences in terminology usage and in the way issues are conceptualized between professionals and users (Rotondi, Sinkule, et al., 2005). Thus, though a given task may have had a different primary goal, all tasks were structured to collect data that would allow us to refine terms and concepts to make them more familiar, more focused, and less ambiguous to users, and more inline with usage users preferred.

Task A: Link Meaning and Predictability—In Task A, labels for the website (e.g., link labels, titles of resources) were evaluated (Spool, Scanlon, Schroeder, Snyder, & Deangelo, 1997). Each participant was presented with a series of labels. Participants were asked to read each aloud, asked whether they had any difficulty reading or understanding any of the words, and for alternative words they preferred. Testers asked specifically about difficulties they had noted. Then, to determine whether a title conveyed appropriate information for organizing or representing resources on the website, each participant was asked, “What do you think this means?” then, “What would you expect to find here?” All responses were recorded and analyzed.

Task B: Link Meaning, Predictability, and Differentiation—In Task B, we tested the adequacy of labels (e.g., links) from Task A to convey their intended meanings, organize resources, and facilitate navigation (Fuccella, 1997). Each participant was given a) several cards, each had a label written on it, which was intended to be used to “organize” information on the website (e.g., a link from the homepage, a table of contents heading); and

b) a list of cards with titles of website resources and articles. Participants assigned each of the titles to one of the labels provided and explained the reasons for each assignment.

Task C: Card Sorting—Using the title cards from Task B, a participant was asked to organize the cards into groups that he or she found to be meaningful. The participant was then asked to make up a label for each of the groups that were created. The purpose of this task was to gain insights on, and ideas from, how users organized the information and the labels they created for their groupings.

Task D: Vocabulary—Each participant was given a list of words to read and define, to identify words that participants misunderstood and/or preferred. The words included those that users showed some confusion about meaning in prior testing or that the research team judged as potentially confusing to users.

Task E: Article Comprehension—In a traditional task we have previously employed, each participant was asked to read aloud documents for the website and to identify any words or concepts he or she did not understand and/or to identify preferred alternative wording. As a participant read a document, a research assistant made notes of things that were easy or difficult. At the end of the passage, each participant was asked about the difficulties noted, and ways to improve the material.

Usability Testing Phase 2: Testing Alternative Website Designs

Using common usability guidelines (IBM, 2001; Koyani et al., 2003; Krug, 2002; Spool et al., 1997) and what had been learned from previous usability testing (Tasks A – E, described above), including preferred vocabulary and user-based concepts, seven distinct website designs were developed. Each design presented a different theoretical approach to organizing and presenting the same resources and information. Initial testing caused us to reject four designs immediately and perform more thorough testing on the three remaining designs. Because attention and concentration deficits were expected to introduce challenges for many participants, only two of the three alternative homepages, chosen at random, were tested on each participant in order to limit the amount of time and potential burden to complete the testing. Based on these results, a final eighth design was created.

Ability to Navigate

Task F: Website Navigation—For each version of the homepage, participants were asked to choose the link where they expected to find information on a specified topic or resource (e.g., “Where would you find information on treatments for schizophrenia”) or to accomplish a task. Each link pointed to a single page with a brief phrase describing the contents. Each choice was scored as being either “correct” or “incorrect.” Participants were allowed to make up to four successive choices, as needed; after a choice, they were returned to the homepage. The purpose of this task was to compare user accuracy with the different designs. Once a participant completed the tasks for both designs, he or she was asked which design was preferred and any aspects of either design that were liked or disliked. The answers were recorded.

Results

Task A

This task, completed by 30 persons, assessed the appropriateness of the labels that had been developed for the website links, module names, and resources. As an example of this, one proposed module of the website was the Needs Module. This module was designed to help users identify and take steps to meet their needs. In an attempt to be more explicit and concrete, the titles of articles and resources in this module were presented as statements of the form “I need X.” For example, “I need to understand what causes my schizophrenia.” Participants had difficulty understanding the structure of these statements. They could understand the “I need,” or the “X” component as stand-alones, but when combined many had difficulty with this type of abstraction. Participants encountered added difficulty with statements that were long or convoluted. As a result, these compound labels were simplified to present only the “X” component, such as “What causes schizophrenia.” When interpretations of wordings were inconsistent, alternatives were tested until good understanding was achieved. Difficulties were also encountered with identifying the meaning of succinct one and two-word link labels. Interpretations were commonly too literal or tied to personal experiences, and many were simply not understood. Variations in wordings for succinct labels were tested, often with limited success. Table 2 provides examples of some of the successive wording changes that lead to adequate understanding (75%). Some examples converged rapidly to consistent interpretation by participants. The entries illustrate several types of successive changes; for example, number eight in Table 2 illustrates progression from a professional to user perspective. Example three proceeds from relatively abstract and succinct to more explicit and longer, to functionally explicit, to simplified functionally explicit.

Task B

In this task, 16 participants assigned titles of resources to one of several labels provided. The purpose of the task was to assess the ability of the website’s organizing labels (i.e., links and headings) to facilitate accurate navigation and identify areas where changes in concepts and wording were needed. The assignments of titles to labels, as well as the reasoning for these assignments, were used to modify both. It became evident over the course of testing that some participants used very concrete and personal meanings when performing this task. For example, one title to be assigned to a label was “Getting help to pay bills.” One set of the label options was “Help paying bills,” “Information for Families,” and “Support Group.” Several put this title with “Information for Families.” The reason provided was that their families were where they went when they needed money.

Task C

Six participants were provided with titles of resources for the website and asked to create headings to organize the resources. The headings suggested for organizing the titles varied greatly, and participants devised three-to-five broad headings, which were relatively nonspecific, sometimes idiosyncratic, and did not always give a clear indication of what one would find with a particular heading. As an example, for the over 50 titles (see Table 2 for examples of titles), one participant suggested three headings, “Social Services,” “Health,”

and “Financial Counseling.” If a user wanted information about getting help paying medical bills, this information could easily fit into any one of the three categories. Another participant suggested the headings “Consumer proactive,” “Concerns regarding prisoners,” “Information regarding the system,” “Issues regarding living in the community,” “Consumer-provider communication,” and “Consumer long-term concerns.” In this example, many would not understand the idiosyncratic meanings of these headings. The resulting structure would require a great deal trial and error in order to locate information. Based on these observations, we discontinued Task C, and it was concluded that the research team would develop headings and use persons with SMI to test their appropriateness and suggest modifications.

Task D

During previous tasks, words and phrases that participants did not understand or had difficulty with were noted and replaced with preferred terminology that at least 75% of those tested understood. Task D used 16 persons assess understanding of specific vocabulary which there was question about whether alternatives were needed. Some of the vocabulary words, which are commonly used by professionals, are shown in Table 3. Less than half those tested understood the terms “relapse” or “psychosis.” In an effort to improve the readability of the website, any terms participants preferred in place of those that were tested were noted and incorporated into the website when appropriate.

Task E

Four participants were asked to read articles developed for the website. Changes to the website’s materials had been made based on previous testing, including substituting preferred words and concepts, reducing the reading level of materials, and adjusting titles. Based on previous testing results, articles were written in a two-tiered format to accommodate those with greater cognitive deficits. This format began with one or two paragraphs that covered the topic of the article, which were written at a reading level no higher than the seventh grade. The remainder of the article was allowed to increase in reading level, though an attempt was made to stay at or below an eighth grade reading level. The reading levels of these materials were an important consideration. In spite of subjects’ education levels (see Table 1), the cognitive deficits of SMI can cause a downward shift in abilities (Goldberg et al., 1990).

All participants were able to read and understand both tiers and had no difficulty with the sentence structures or the vocabulary. None of the participants indicated that the information presented was too hard to understand, and all indicated that they thought it was very valuable information. All showed a strong interest in taking the materials they had read home. The success of their performance suggested that the two-tiered design was useful and the website materials were being presented at a level that was more accessible and understandable to the target audience than in the original one-tier design.

Task F

Based on the previous testing results and known cognitive functioning characteristics of intended users, several dimensions were identified as potentially being central to a

successful design: concreteness, memory demand, and consistency. Three different design models were used to create four websites (see Table 4). Each model represented a different conceptual approach to addressing these dimensions

The first model employed a strict modular abstract design (see Introduction), with two navigational dimensions (see Figure 1). This utilized a constant navigational tool bar at the top of each page, which listed modules of the highest-level content areas of the website. Along the left side of each page was a variable navigational toolbar. Its buttons changed to be appropriate to the location in the website. The labels used in this design were selected from those that showed the best performance in the previous usability tasks while still being succinct (i.e., abstract). The use of high-level modules, coupled with strict separation of navigation and contents, presented the most prolonged progressive disclosure of information of any of the designs and resulted in the deepest hierarchy. To be effective, the variable navigational links required both more memory and context awareness on the part of users in order to comprehend one's spatial location in the website and its relationship to these links.

The second website (see Figure 2) was a hybrid of Models 1 and 3. It contained modifications to Model 1 to better accommodate those with cognitive deficits and address potential difficulties with characteristics of this design revealed during the usability testing (e.g., a high reliance on memory stores, the need to interpret abstract labels deep hierarchy). It had one navigational dimension, which was a table. This listed modules of traditionally high level topic areas with succinct labels in the left column using brown highlight, and lower level topic modules with more explicit labels (i.e., less succinct) in the right column in blue highlight. The columns were differentiated from each other by color to reinforce their conceptual distinction. The succinct labeled modules were chosen from those identified during usability testing that were the most recognizable by users. Based on the success of this feature in our previous TBI website, the "selected" item in the table appeared in yellow highlight, to help users identify their choice and where they were in the website.

The hybrid nature of this design meant that some characteristics of Model 1 were only partially implemented. The main dimensions of a strict modular abstract design employed to accomplish this design included a) the contents were organized into discrete conceptual groups (i.e., a modular design); b) navigation pages were separated from content pages; c) page content was organized into discrete areas; d) a single constant navigational element was provided that presented both primary or highest level content areas, and lower-level modules. To accommodate those with cognitive deficits, a table was used instead of a toolbar. This accommodated a larger number of links and font size and allowed for the inclusion in the navigational element of lower-level modules with more words than are used in succinct labels. It did not include a variable navigational tool bar in order to simplify and reduce the amount of variation across, navigational pages, and thus reduce the amount of abstract thinking required.

The third website model (see Figure 3) was created to respond as fully as possible to the design issues identified in the usability testing. Primary issues were to reduce the reliance on the cognitive abilities, such as working memory and spatial ability, which are typically heavily involved in navigating a site, and to reduce the need to think abstractly, which is

involved in tasks such as making link-label associations and interpreting the meanings of titles. To accomplish this, we designed what was termed a “flat explicit weak-modular design.” The two primary focuses of this design were to have as shallow of a hierarchy as possible and to use explicit versus inferential or succinct labels. All other dimensions of the design model were secondary to these. Additional dimensions of the design included a) a modular structure that was organized around conceptually lower level topic areas, which thus presented a relatively higher number of modules; b) separating navigation from contents, to the extent permitted by the primary focuses, which was accomplished using a single navigational list of links and; c) use of explicit labels (e.g., links, titles) that incorporated terminology identified from consumers during usability testing. To achieve a flat hierarchy the homepage had pull-down menus that presented the entire contents of the website. The label for each pull-down box represented a low-level module. To navigate, a user needed to click on the down arrowhead at the right end of a pull-down box to produce a menu of links. Each link represented a final website destination (i.e., contents). A user could then move the cursor down the links, click on one and be taken to that selection. This design had the shallowest structure of the three. A user could go from the homepage to virtually any final destination of contents in one page with only two mouse “clicks.” Of the three, this design contained the most features focused on reducing the cognitive difficulties that persons with SMI might experience when navigating a website. It presented the shallowest structure and simplest hierarchy, making it the most difficult in which to get lost. There were more options to choose from on the homepage, but it preserved a user’s context by reducing the need to leave the homepage to navigate through successive pages of the site to obtain content. It had the longest and most explicit link labels, requiring the least amount of interpretation. However, this design had the fewest shortcuts, required the most reading to navigate due to the longer link labels, potentially required searching through more information on the homepage to identify desired information, and required the most meticulous mouse manipulations. A user needed to maneuver to one of the small arrowheads in a pull down box, click the arrow, move down to one of the links that appeared (see Figure 4), and finally click on the link to go to a resource.

Twenty-six persons completed Task *F*, of these a higher proportion of users were able to complete 64% of the tasks when using the flat design than with the other two designs ($\chi^2 = 7$, $df = 2$, $p = .03$). This trend held for users over the full range of functioning scores (GAS). Additionally, 36% (see Table 5) were correct on their first choice with the strict modular design (see Figure 1), 54.3% with the hybrid design (see Figure 2), and 57.3% with the flat design (see Figure 3). Overall, more participants said they preferred the appearance (e.g., larger font size, attractiveness) of the hybrid design than the other two designs. The highest proportion of correct first choice responses occurred with the flat design. Model 2 had the highest number of correct second choices; however, because participants were returned to the homepage after an incorrect choice, this is likely an overestimate of what would happen in practice, when users might choose from the submenu they were presented with, versus returning immediately to the homepage, and thus proceed further down an incorrect path.

Participants who did not prefer the flat design noted that the font in the menus was too small, the information in the pull-down menus appeared cramped and difficult to read, and

the most mentioned comment was that it was difficult to move the mouse over the small arrowhead where one needed to click to produce a menu. Nevertheless, participants did note that the categories presented in this design highlighted issues that were of particular interest to them, that this same information would have been more difficult to find in the other designs because the categories were more vague and likely to require additional searching. Those who preferred the flat design cited the design as offering, “easier access to information,” “more information to choose from,” a feeling that the website was “more self-explanatory and easier to understand,” and that they “liked having all the choices of information in front of them” without the need to search through the website.

The participants who preferred the hybrid design found the fonts “easy to read,” and “liked the bigger boxes better [than the small text displays of information in the other designs].” Although 54% of participants preferred the visual display of this design, some had difficulty interpreting the two-column table menu. They thought that a single row was one choice and did not recognize that each column in a table contained separate choices. For example, when asked where to find information about the causes of schizophrenia, some would answer, “Support Groups Learn About Schizophrenia,” as though it were one choice.

The Final Website Design: Model 4

Based on the usability testing, Model 3 was determined to be the most accessible design. In addition to this being the design that produced the most accurate navigation, it had several design features that were more appropriate for persons with SMI than the other two. It accommodated quite long labels for links and titles, thus reducing or eliminating a user’s need to think abstractly. All contents of the website could be presented on the homepage. This produced a one page deep website and created a simple hierarchy that reduced the amount of navigation required to access contents, the need to develop a mental model of the site, or the chances of becoming disoriented or lost in the hierarchy of the website.

Several weaknesses of this design were identified in the usability testing. To address these, the following modifications to the design were made (see Figure 5). The arrowheads in the drop-down menus, which were challenges for many users especially considering that most were novice Internet users, were replaced with pop-up menus. A user simply needed to pass the mouse over what had been a drop-down menu heading, and the menu would pop-up automatically to the right (see Figure 6). This eliminated a mouse “click,” and made it possible to navigate from the homepage to any final destination of the website with only one mouse click. These had the added advantage of not obscuring the other category choices that were below, as the drop-down menus had done (a common feature of drop-down menus, Figure 4). The headings were right justified to make them contiguous with the pop-up menus to ease cursor movement from one to the other. The pop-up menus were sized such that, regardless of the number of choices presented, they occupied an equal space to present a more consistent and, thus, less confusing visual display and to cover the potentially distracting text behind them on how to use the website. The heading rows as well as those of the pop-up menus were expanded, allowing larger font and making it easier to maneuver the cursor. “Radio buttons” were added to the headings so users would know which category menu they were viewing, reducing their confusion and cognitive load. We added a brief

description explaining how to use the site, which users see before they make a choice. This is covered by the pop-up menus to reduce clutter and distraction, because once users produced a pop-up menu they did not need to see this text.

One of the other design features was the addition of a constant navigational tool bar at the top of each page. This provided a “shortcut” for savvy users and an advanced feature that novice users might benefit from. Each constant navigational link or “button” of this tool bar was enclosed within brackets ([]) to inhibit the tendency of some persons with SMI, identified in the usability testing, to read across a row as if it were one continuous item. To help avoid disorientation, the homepage was constructed using a “frame” that kept the tool bar at the top of the display even as a user scrolled down the page. Given the potential vulnerability to over-stimulation, bright colors and icons were avoided; graphics were not used; and the welcome message (superfluous stimulus for repeat users) was placed near the bottom of the home page.

Discussion

The usability testing identified several characteristics of persons with SMI that have implications for an effective website design model. Participants had difficulty with tasks that involved abstract reasoning and sometimes made highly concrete, personal, and idiosyncratic associations between the resources they were asked to find and the labels from which they had to choose. These personal meanings dominated their interpretation of labels and, thus, navigational decision making. One of the fundamental requirements of a strict modular abstract design (Model 1) is that users must be able to extract the correct meaning from succinct labels in order to navigate a site. The tendency to make personal associations could make it impossible to develop succinct labels that can suggest the same meanings to all or even most users. This poses a fundamental challenge to this model of website design and to current website design guidelines for persons with SMI and others with cognitive deficits.

The results of this work indicate the benefits of a flat hierarchy, explicit labeling, lower-level modules, familiar phrasing, and presenting text at a low reading level. This was the best model tested to accommodate the cognitive deficits and respond to the usability findings. These characteristics reduced the need for users to a) rely on working memory stores and the visual-spatial sketchpad to create a “mental model” of, memorize, or explore the layers of the site; b) interpret the concrete meanings of succinct abstract links and labels; c) grasp the logic used by designers to organize content into categories; and d) use executive functions to plan and execute multiple step searches to find information. It allowed users with cognitive deficits, who made highly personal associations and had difficulty thinking abstractly, to understand the presentation, locate desired information, and explore the site effectively, with no requirement to learn the structure. The flat explicit design presents users with more information and more choices on the home page, but users only need to go one page deep to obtain desired content. For a person with diminished or impaired cognitive abilities, one who is less likely to learn from past experience, a structure with more levels will be more difficult to learn and will offer more opportunities for confusion and navigational errors. Such observations, coupled with the accuracy of the alternative designs

that were tested, indicated that the most successful website would be the flat explicit weak-modular design. This is an appropriate design for those with cognitive deficits and who have difficulties making a mental model of a site, but may not be appropriate for all populations. It requires more time to read and search the homepage to find content and, thus, may be more tedious to navigate for those who are able to become savvy users.

Our model represents an extreme in user centered design. As Norman points out, the designer always struggles with three models of a system—the user’s model, the system model, and the designer’s model (Norman, 1988). We would contend that there is a fourth mental model lurking in the design of *medical* websites—that of the health care professional. Typically, these websites present a model that reflects the designer’s perception of the professional’s perception of the users’ needs and expectations as moderated by the technologies’ limitations. Our approach works to insure that the influence of the mental models of the medical and design professionals involved are minimized. This design, for applications where users make the decisions (navigation and content), may be contrasted with “wizards” and other template models (e.g., questionnaires)—applications where the designer a priori makes the navigation and content decisions independent of the users. These present a quite different set of goals and circumstances, for which a successful design has been found to be quite distinct from our model (Chinman et al., 2004). In the wizard and web-based questionnaire applications, the information presented on a screen can be quite sparse (e.g., presenting only one question or even a part of a question on each screen), requiring many more screens and levels in a website’s hierarchy to complete tasks; however, the number of levels a user faces to supply information (e.g., complete a questionnaire) is practically irrelevant to the ability of a user to navigate, because users do not navigate; navigational routes are preprogrammed. Our model makes every effort to reduce the “gulf of execution” and the “gulf of evaluation” (Norman, 1988, p. 49). The actions users are allowed to execute and the information users have to evaluate have been modeled as concretely and completely as possible in the terms of the end user. In many ways, this is the text equivalent of what Dertouzos lays out as the natural language dialog goals of human centered computing (Dertouzos, 2001). Our approach, compared to the generalized abstract navigational model, help to define two extremes on a continuum for web interface designs. When the interaction is unstructured and user controlled, getting the user model right and reducing the gulfs is critical. In highly structured interactions, where the process controls the interaction, the user model may be less important for navigation. Thus there is a significant difference in the importance of the user model when the website seeks to provide information that responds to hundreds or even thousands of different possible user needs versus a site that walks a user through a series of predetermined steps to complete an application or fill out a form. These two models may have implications for other types of interactions, including face-to-face and telephone. Where *decisions* must be made, it appears that the ability to go through the broad areas of choice can be helpful, possibly even in wizards; but when no decisions are being made (e.g., only information is being supplied), it is better to be as simple and *information sparse* as possible.

Implications for Mental Health Services

One practical way to provide a wider group of persons with SMI and their families' access to necessary services is through the use of the Internet (Greist, 1998). Online information has the ability to reduce the gap between the haves and the have-nots and create accessible services that can assist persons with SMI and their families. While some lower income populations may be less likely to have computers or Internet access in their homes, public services, such as libraries, increasingly provide such access, and studies have found that when access is made available, these populations become excited and invested computer system users (Eng et al., 1998; Rotondi, Haas, 2005). Since underserved populations often have reduced access to many resources including health insurance, they are likely to have more health care needs; thus, providing the opportunity to access online services may be cost-effective and of significant benefit. Access to technology is not the only impediment, however. These results indicate that the Internet can be made more usable to persons with SMI, but that the way content is presented affects accessibility. Websites conforming to current guidelines may not be the best at promoting such use.

Conclusions

Underserved populations, such as those in rural areas and those who face economic and cultural barriers, may lack access to illness-specific information and services. Online services, if appropriately designed, may help to bridge this gap. The findings of this study are unique in that this study was the first and to date the only such investigation, to our knowledge, conducted with a sample of individuals with SMI. Research on usability standards for website design is abundant, but this research does not focus on the needs of persons with SMI or cognitive deficits. The results of this study indicate that not all of the established website usability guidelines, nor the prominent design model for the general population, apply to persons with SMI and cognitive deficits. The findings indicate that those with cognitive deficits associated with SMI do have distinct design needs. Many individuals with schizophrenia and other severe mental illnesses will most likely have difficulty learning and remembering the structure of a website and how to use it. This is likely true for other conditions, such as traumatic brain injury and any condition that may involve cognitive deficits such as is experienced by some elderly or some persons with post traumatic stress disorder. They may also experience problems in accurately interpreting or understanding the organization and conceptual categorization of a design and, subsequently, in locating the information they are seeking. However, none of these are so great an obstacle that it is unfeasible to design a website that can be utilized by these populations. If web designers consider the cognitive needs of this population, the Internet and the World Wide Web can be beneficial and practical for those with SMI. Future research is needed to further assess these findings, identify additional design needs of this population, and identify the links between specific cognitive deficits and the design elements useful to accommodate those deficits.

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Appendix

Literature and Web Search

In the literature search, several terms were used to identify usability studies and website design guidelines (e.g., usability, guideline, accessibility, web, design, standards), and terms, including several suggested by librarians at the Information Sciences Library at the University of Pittsburgh to help identify references from non-healthcare focused data bases, to identify references that involve SMI (e.g., SMI, severe mental illness, mental health problem, mental disability/ies, mental health disability/ies, mental illness, psychiatric disability/ies, mentally ill, and psychiatric patient). Sixteen databases were searched: Medline, PsycINFO, CINAHL, Academic Search Premier (provides indexing for over 3,600 scholarly journals), Applied Science and Technology Abstracts (indexes articles in over 575 English-language periodicals worldwide in applied sciences and technology), Information Science & Technology Abstracts (provides worldwide library science and information science records from more than 450 publications), Academic (Lexis-Nexis; provides full text and citation access to information in the reference, business, medical, and legal disciplines), MathSciNet (provides access to reviews of the world's current mathematical literature, other subjects covered include computer science), National Technical Information Service (serves as the largest central resource for government-funded scientific, technical, engineering, and business related information available today), Expanded Academic ASAP (provides indexing for over 5,300 scholarly and general interest journals embracing all academic disciplines), ERIC (a digital library of education-related resources that contains more than 1.1 million citations), ProceedingsFirst (contains citations from worldwide professional meetings, conferences, expositions, workshops, congresses, and symposia in the area of computer science), Library and Information Science Abstracts (an international abstracting and indexing tool designed for library professionals and other information specialists; currently abstracts over 440 periodicals from more than 68 countries and in more than 20 different languages, and covers topics including computer science applications, information science, information technology, Internet technology, medical information, online information retrieval, telecommunications, and the World Wide Web), the Web of Science (which includes databases such as Science Citation, Index Expanded™, Social Sciences Citation Index®, Arts & Humanities, Citation Index®, and has indexing for over 8,700 scholarly journals), Linguistics and Language Behavior Abstracts (indexes 1,246 that cover developments in disciplines concerned with the nature and use of language), and

Scopus (offers access to 14,000 peer-reviewed journals, and 30 million articles, covering scientific, technical, medical and social science literature from more than 4,000 international publishers).

In addition, we performed an Internet search. This included the use of well known search engines (e.g., Google), and searching several prominent websites that contained a focus on usability and accessibility (e.g., the World Wide Web Consortium (W3C), the International Organization for Standards (ISO), the U.S. Department of Health and Human Services site, Usability.Gov, the government's section 508 site, Microsoft Corp., IBM Corp., UniversalUsability.org, the World Institute on Disability, the Trace Center).

Figure 1.
Strict modular abstract design homepage: Model 1.

Figure 2.
Hybrid design homepage: Model 2.

Figure 3.
Flat explicit weak modular design 1: Model 3.

Figure 4.
Model 3, flat explicit weak-modular design 1 with an open drop-down menu.

Figure 5.
Final home page design: Model 4.

Figure 6.
Final homepage design with an open pop-up menu.

Table 1**Participant Characteristics: Demographics and Background**

Variable	<i>n</i>	Percent
Persons with SMI ^a		
Self-reported primary diagnosis		
Number of persons with an SMI	98	100
Schizophrenia or schizoaffective disorder	49	50
Major depressive disorder	6	6.12
Bi-polar disorder	9	9.1
Undisclosed SMI	34	34.7
Sex		
Female	87	88.8
Race		
Caucasian	49	50
African American	37	37.8
Asian American	1	1
Did not report race	11	11.2
Age (years)		
<31	11	11.2
31–40	20	20.4
41–50	40	40.8
51–60	15	15.3
>61	4	4.1
Did not report age	8	8.2
Education level		
Less than a high school education	11	11.2
Graduated high school or received GED	32	32.7
Vocational training/Some college	23	23.4
Undergraduate degree	5	5.1
Did not report educational level	27	27.6
Overall Level of Functioning (GAS)		
1–20	0	0
21–40	11	11.2
41–60	72	73.5
61–80	12	12.2
81–100	3	3.1

Note. SMI = Severe Mental Illness; GED = General Education Development High School Equivalent Diploma; GAS = Global Assessment Scale.

^a
n = 98.

Table 2

Original and Final Wording of Titles

Original wording	Successive wordings to develop consistent interpretation			
	1 st	2 nd	3 rd	4 th
1. Discussion groups	Therapy groups	Support groups		
2. Questions & answers	Ask the mental health professional	Ask our experts your questions	Ask your question	
3. Q & A library	Question and answer library	Previously asked questions library	Previous questions and answers	
4. Reference library	Library	Reading materials	Educational materials	
5. I need help dealing with the day-to-day issues, stresses and problems I face	Help dealing with the day-to-day problems you face	Dealing with problems	How to solve problems	
6. Information for families	For families	1 Help for families. 2 How families can help manage the illness.		
7. I need to know local professionals who are knowledgeable about schizophrenia.	Treatment	Finding treatment	Find local professionals who treat schizophrenia.	Who treats schizophrenia in my area?
8. Relapse	Rehospitalization	Will I be in and out of hospitals the rest of my life due to this illness?	How many more times in my life will I be hospitalized?	Will I get sick again?
9. I need to know how long an acute episode will last, and how long it will be before my next episode.	Learning how to recognize the early warning signs of a possible relapse.	How can I recognize the early warning signs of a possible relapse?	What are the warning signs of getting sick again?	
10. I need to know what causes schizophrenia.	What causes schizophrenia?			

Table 3

Knowledge of Vocabulary

Vocabulary word	<i>n</i>	Percentage correct
Persons with SMI ^a		
Psychosis	6	33
Relapse	7	44
Consumer	7	44
Mental health worker	7	44
Episode	8	50
Involuntary admission	8	50
Diagnosis	9	56
Hallucination	9	56
Mental health professional	9	56
Paranoia	10	63
Delusion	10	63
Nurse	10	63
Prescription	11	69
Psychologist	11	69
Psychiatrist	11	69
Social worker	11	69
Coping	13	81

^a
n = 16.

Table 4**Conceptual Characteristics of Website Design Models**

Model 1: Strict modular abstract design		Model 2: Hybrid modular design	
1	Multi-level, deep hierarchy	1	Hybrid between Models 1 & 3
2	Modular ^a		• Included modules in left column of navigational table with traits similar to Model 1, and those in right column having traits closer to Model 3.
3	Homepage presents only high-level conceptual modules ^β		• Has 5 modules formed around high-level concepts, and 5 lower-level concept modules
4	Succinct ^γ	2	One navigational dimension ^ε
5	Strict separation of page functions ^δ		Compared to Model 1 this added a more explicit component with a shallower hierarchy, had one navigational element.
6	Two navigational dimensions • One is invariable and one varies by website context/location, but both are on every page. This creates variable consistency in navigation		
Traits 2, 3, & 5 produce the most prolonged progressive disclosure of information and the deepest hierarchy.			
Model 3: Flat explicit weak-modular design I		Model 4: Flat explicit weak-modular design II	
1	Flat, two-level hierarchy	1	Flat, two-level hierarchy
2	Modular ^a	2	Modular ^a
3	Low-level modular concepts ^ζ	3	Low-level modular concepts ^ζ
4	Explicit ^η	4	Explicit ^η
5	Reduced functional separation ^θ	5	Reduced functional separation
6	One navigation dimension ^{ι, κ}	6	One navigational dimension ^ι
Traits 2, 3, & 5 produce the shallowest hierarchy			

Note.

^a Contents are organized into conceptual categories.

^β Modules organized around high level topics and thus has relatively fewer modules on the home page. Initial navigation choices/links take user to a relatively less focused and larger amount of information.

^κ The initial module choice takes users to a relatively focused amount of information with each choice.

^γ Labels are brief (e.g., one or two words in length), and thus tend to be relatively abstract or inferential.

^δ There is a strict separation of page functions, with pages for navigation (e.g., high-level module navigation, lower-level sub-module navigation), or contents.

^ε This produces absolute or invariable consistency in navigation across pages.

^ζ Modules organized around lower level concepts or topic areas and thus has relatively more modules. Takes users to a smaller amount of relatively focused content with each choice.

^η Labels are long and require less inference to detect meaning.

^θ There is a reduced separation of page functionality, and thus, a relatively abbreviated progressive disclosure of information.

^ι The flat structure eliminated advantages of the 2nd variable dimension.

Table 5

Design Comparisons: Participant Accuracy and Preference (in Percentages)

	Model type		
	Flat explicit weak-modular (Model 3)	Hybrid (Model 2)	Strict modular abstract (Model 1)
Choice	Identified correct link to the requested information		
First choice	57.3	54.3	36.0
Second choice	10.0	15.8	0.0
Third and Fourth choice	5.0	3.2	0.0
Total correct over all 4 choices	72.3	73.3	36.0
Design Preference			
Participants who preferred design [‡]	42	54	4

[‡] Two participants had no preference.