DESIGN OF A RICH – PROSPECT BROWSING INTERFACE FOR SENIORS

A Qualitative Study of Image Similarity Clustering

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ABSTRACT

This paper examines inclusive design delivery through interface design, with a particular focus on access to healthcare resources for seniors. The goal of the project was to examine how seniors are able to access drug information using two different online systems. In the existing retrieval system, pills are identified using a standard search interface. In the new browsing prototype, all of the pill images appear on a single screen, where the user identifies images by clustering the pills displayed by choosing similarity criteria related to the database search terms (e.g., all white pills or all pills of a certain size). The feedback mechanism in this interface involves re-organization of the pill images that are already visible to the user. We used a qualitative, task-based verbal analysis protocol with 12 participants aged 65 and older who were asked to locate pill images in each database and to discuss their preferences for navigation, aesthetics and the results that appear on the screen. By assessing the features of both interfaces, the results suggest possible models that could be applied in meeting seniors' information retrieval needs.

INTRODUCTION

As the general population ages (and as life expectancy rates increase), seniors are increasingly faced with complicated medical regimes. Sorting pills, to ensure that certain medications are taken at particular times of the day with or without meals, can be a daunting task for many patients, yet this task is a vital part of personal health management. As individuals age, visual and/or motor impairments make sorting, holding and identifying pills a challenge. Designing effective reference materials—including websites—can aid in patients' and caregivers' awareness and recognition of the range of available medications and help them to locate valuable drug information (e.g., side effects). This project was designed to explore the viability of a prototype,

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a visually based interface that would meet seniors' specific searching and retrieval needs. This empirical study addresses a theoretical issue raised by Ruecker and Chow (2003), which called for further research into the use of browsing strategies in interfaces for seniors accessing health information of various kinds. Qualitative interviews were used to explore participants' general information searching strategies, and computer tasks (employing a verbal analysis protocol) were used to assess two interfaces – including a prototype that was designed to bridge the physical (e.g., vision-related) and cognitive/emotional (e.g., issues of trust related to health information) needs of older adults.

The goal of this project was to see if an alternative visual browsing interface, showing photographs of 1000 pills, could be useful for seniors interested in pill identification. Usefulness in this case involved a number of factors, ranging from the basic question of whether 1000 photos would simply be overwhelming, to concerns about the best methods for providing tools to manipulate the display, down to detailed questions about specific design choices relating to contrast, legibility and control size. The images could be magnified and also clustered by participants based on similarity in two visual dimensions: color and shape.

INCLUSIVE DESIGN — A REVIEW OF THE LITERATURE

Previous relevant research includes a wide range of studies on information design, browsing interfaces, information-seeking behaviors and public health information. In the design of human-computer interfaces, for example, Shneiderman and Plaisant (2004) provide a comprehensive overview of issues to consider, including concepts drawn from human factors, principles of interaction design, the importance of expert

evaluation and user testing, and the role of support materials such as tutorials and help systems. In the more specialized area of browsing interfaces, a wide variety of examples have been discussed, including Small (1996) who proposed a 3D prospect view for browsing texts of Shakespeare's plays and Pirolli et al. (1996) whose scatter/gather browser represented documents by colored dots that could be organized under user control. Bederson (2001) describes a system for organizing thumbnails of images. More recently, designers working with the public API from www.flickr.com have developed a number of browsing interfaces that extend some of Bederson's ideas through tools such as the color picker by Bumgardner (2005).

In addition to the discussion of browsing interfaces and their features, there has also been some discussion in the HCI community of the methods of evaluation. For instance, Plaisant (2004) suggests the need for new and more comprehensive strategies for evaluating the success of browsing interface designs. In particular, she emphasizes the importance of considering new metrics that involve not just isolated measures of performance or preference, but also look at the longer duration of user interaction with an interface, both within a given session and across multiple sessions: "we need to consider other evaluation approaches that take into account the long exploratory nature of users' tasks, the value of potential discoveries or the benefits of overall awareness (p. 109)."

In the area of information design specifically for seniors, there have been a number of useful studies relevant to interface development. Ogozalek (1994) compared text and multimedia as information media for seniors, and found that multimedia gave better results in measures of both performance and preference. In fact, her participants preferred video to both online and printed text, suggesting that reducing the amount of required reading can make information more accessible to the elderly" (p. 70). In terms of design strategies, the principles of universal (U.S.) or inclusive (U.K.) design suggest that the number of successful and satisfied users of any technology can be increased by giving conscious attention to the needs of specialized users and incorporating those needs into the design brief, not of specialized technologies, but of technologies intended for use by everyone. A classic example of this approach is the design of a door knob in comparison with a door lever: door knobs require grip strength, while door levers do not even necessitate grasping. Door levers are not therefore just a better technology for anyone who has trouble with grip strength, but are also beneficial

to people whose hands happen to be full of grocery bags—the door can still be negotiated using an elbow. In their confirmation of this strategy in the context of web browsing, Chadwick-Dias et al. (2003) identified that participants aged 55 and older experienced more difficulties than younger participants in using the web, but also found that specific design changes based on needs identified for older users also improved performance measures for younger individuals.
However, as Shneiderman and Hochheiser (2001) point out, the goal of universal usability can often best be met through strategies that involve layered approaches, where different kinds of users are able to select appropriate degrees of interface complexity. Another factor to keep in mind during the research process is that it is as easy to stereotype the 'senior' as it is any other group. In fact, people over 65 represent a heterogeneous mix of individuals who may share a social identity, but in fact, have as many differences as similarities (Ogozalek 1994; Ito et al., 2001). That said, the proper identification and use of medication by patients is an ongoing concern in the health information community (Alemagno et al., 2004; Gleckman, 2003; Logue, 2002; Ahrens, 2003; Jorgenson et al., 2001). Seniors are particularly vulnerable to difficulties in this area, since many of them deal with complicated treatment arrangements involving multiple medications, each with its own requirements and precautions. Systems for storing pills to manage daily regimes are also vulnerable to difficulties when the pills become disarranged, at which point it becomes particularly important to correctly identify pills that have been disassociated from their packages

DESIGN

This project implements in a preliminary form a strategy for research interfaces based on the combination of factors that Ruecker (2003) uses to define a rich-prospect browsing interface. The purpose of these factors is to increase user control over the research task and to provide a heightened sense of cognitive reassurance for searchers. To these ends, rich-prospect browsers show within the default interface some meaningful representation of every item in the collection, combined with tools for manipulating the display. In addition, each representation should access more data, the form of the representation should vary under user control, and the tools should be emergent from whatever data or metadata are available in the underlying database.

The design used in this project is an early attempt to create a rich-prospect browsing interface, and as such it only meets three of these five criteria. It shows a meaningful representation of every item in the collection, has tools to manipulate the display, and provides more information linked to each representation. However, there is only one form of representation, namely the photos of one side of the pills. The prototype also has only generic ways to manipulate the display—sorting by shape or color, magnifying, panning and optional grid-lines—rather than providing tools that are emergent from the data.

Since our proposed users for this study consisted of people aged 65 and over, best design practices for interfaces intended for seniors were followed (Strickler and Neafsey, 2002). These consisted of a wide range of relatively subtle but important design choices, including providing sufficient contrast for controls and images, providing clear visual cues and designing text labels using a comparatively large font size. The rich-prospect tools provided additional features of benefit to this demographic, including the ability to magnify the display by three orders of magnitude.

It is important to note here that using a prototype design that is in its early stages of development is ideal for this type of project, as it allows for user input into the design process prior to investing large amounts of time and/or money on a fully-formed design that may or may not work for real end-users of the database in question. This project was designed, then, in keeping with the work of such usability experts as Jakob Nielsen (2000, 2002), who recommend involving users in the design process before final design stages are completed. However, revised versions of the prototype will address the two design factors missing from the current version: providing opportunity for the user to change the form of the display (e.g., by showing the back side of the pills or by allowing the user to fully rotate a pill); and, providing specialized tools that are emergent from the data—for example, some mechanism to identify potentially harmful drug interactions.

METHODOLOGY

The design-related research questions for the project were: 1) To what extent does interface design affect the usability of online drug databases; and 2) To what extent can visually-based interface design principles facilitate the usability of online drug databases?

Twelve participants, all aged 65 or over and comfortable with basic computer use, were recruited for this project; six men and six women were included, ranging in age from 65 to 80, reflecting a diversity of ages, backgrounds and levels of experience with computers and/or web resources. Ethics approval was obtained for this project and a full disclosure of participants' rights occurred during the consent process; all participants (identified in this paper only by pseudonyms) signed consent forms to acknowledge their agreement to participate in this study. Ads were placed in seniors-only apartment buildings, public libraries and community centers to attract individuals from a range of backgrounds. Qualitative, task-based interviews were conducted which included a 20-minute discussion of participants' general information-seeking strategies and a 40-minute task-based session involving searching for pill information. The interview data provided the context for a series of information retrieval tasks that participants performed using two drug information databases: a publicly accessible, text-based retrieval system (i.e., www.drugs.com website; see figure 1); and, a newly designed, visually-based retrieval prototype that grouped 1000 pill images using similarity clustering (figure 2).

Participants were shown a series of three pills and asked to identify the pills and provide information on each one using the interfaces under evaluation. The task was carried out differently in each interface. The online www.drugs.com site provides this information in the form of a searchable database of pill images; as search terms relate to the characteristics of the pills, a typical search in this database might use keywords such as 'small,' 'round' and 'white,' with results provided on separate web pages. The task in this interface therefore consisted of being given a pill to identify, choosing search terms to enter, then examining the results (both text and images) to see if the pill could be correctly identified. This task was repeated for three different pills.

The owners of the www.drugs.com website gave the researchers their complete database of pill images, allowing the images in the prototype to be exactly the same quality and resolution as those found in the existing website. Since we were re-using these images, we did not have much control over their consistency and resolution, although we did

remove extraneous background colors that were present on a few of the pills. The owners also gave permission to include screen captures of their website in all research publications.

The second interface (figure 2) is a rich-prospect browsing prototype that displays all the pills in the collection at once and allows the user to search by sorting, sub-sorting and zooming in on the various images. Previous work on the design of browsing interfaces suggests that there are a variety of new perceptual advantages and new opportunities for action that can be made available through these strategies (Ruecker 2003; Rodden et al. 2001; Ruecker et al. 2005). The task using this interface therefore consisted of being given a pill to identify, then comparing it to the images on the screen. The images could be grouped in two different ways (color or shape) or in a combination of these ways. The images could also be magnified. When an image of a pill was clicked, the information about it appeared on the left-hand side of the interface.

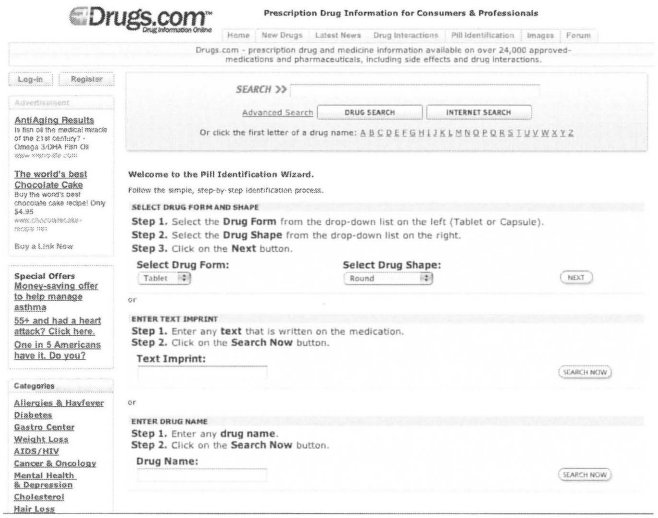

Figure 1. The original interface for pill identification is the one publicly available on the site of www.drugs.com. The interface is a retrieval design with an associated wizard that guides the user through a step-wise process. Only at the last step does an image of the selected pill or pills become visible. (This screen capture is used with permission of www.drugs.com.)

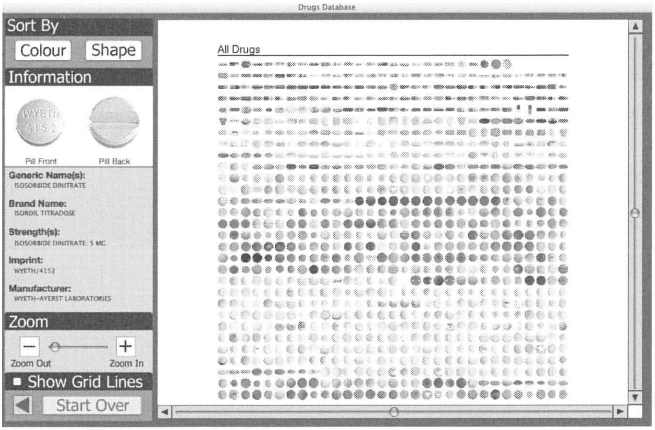

Figure 2. The home page of the rich-prospect browsing prototype shows all the pills in the collection at once, in no particular order.

The related tools allow the user to sort the images by color or shape, which creates subsets that can either be further sorted or else selected for subsequent sorting. For example, someone starting at the home page in Figure 2 would get to the image in Figure 3 by pushing the 'Sort By Color' button on the top left side of the interface. The groups could then all be further refined by also pushing the 'Sort by Shape' button, which would show smaller groups divided by combinations of color and shape. Alternatively, the user might prefer to begin in a different order, first with sorting by shape, then sorting the shape groups by color. Another option is to do the first sort, then enlarge a single group to fill the screen by rolling the cursor over it (the group highlights) and clicking. Subsequently pushing the second button then fills the screen with the sub-groups of the single group already selected. In this case, the other groups are still sorted off in the virtual spaces beyond the edge of the screen—the user can access them by zooming out or scrolling.

One of the side effects of the process of creating and selecting a subset is that it is automatically enlarged to fill the screen. In addition, the interface also allows the user to actively zoom in or out on any of the individual pills (figure 4) or subsets. The tool for doing this magnification task is a slider bar with accompanying plus and minus buttons on the lower left panel of the interface.

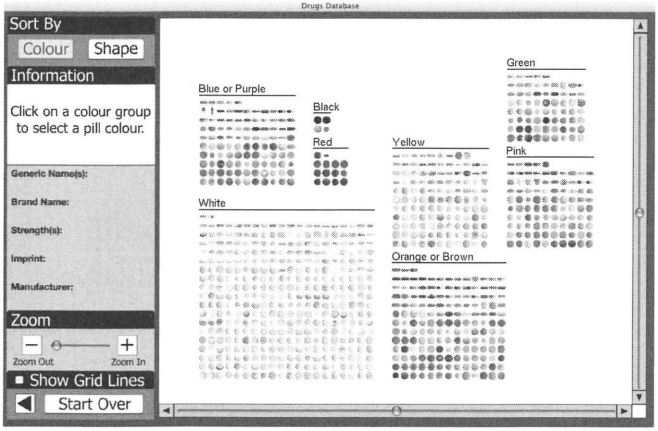

Figure 3. After sorting the display by colour, the user sees the same total number of pills, only now they have been reorganized by groups with group labels.

Figure 4. This screen shot shows the state of the rich-prospect browsing interface once the user has zoomed in as much as possible for closer inspection of a particular pill.

At any point, the user also has the ability to click on individual pills in order to display information about the pill. This information includes the generic and trade names of the drugs, any text imprinted on the pills, and in some cases an enlarged image of the pill reverse. Additional information would clearly be beneficial, especially with respect to possible alternative medication and warnings about potentially harmful drug interactions, but in this study we were primarily interested in the potential of the browsing interface for identifying pills.

Participants were asked to locate information about three different pills in each of the two databases, using color images of pills (both front and back) printed on 3x5 recipe-style cards; eleven pills were examined, in total, randomly assigned across the interviewees. Digital audio recordings were used to gather the interview data and to record individuals' perceptions during the task-based sessions and were fully transcribed. Digital video was used to capture screen images during the task-based activities. A verbal analysis protocol was used to allow participants to comment on their preferences for navigation, layout, aesthetics, etc. in each interface. 'Task completion checklists' were also used to track which search features (e.g., zoom button) the interviewees used on their own and which ones they used only when prompted to do so by the researchers.It should be noted that participants were first asked to search for each pill using any search process and/or feature that they felt was appropriate; once they had done so, the researchers pointed to any additional (unused) features, so that each participant commented on all available search features. This was an important step in the design of the project as some participants simply did not see (or did not understand) particular design features; these findings are discussed in detail, later in this paper.

The digital audio recordings were subsequently transcribed and coded using a qualitative text analysis method described by Given and Olson (2003), which emphasizes the usefulness of developing the coding schema according to knowledge organization principles long established in the library and information science field (figure 5). By balancing requirements for specificity against exhaustivity and precision against recall, this strategy provides a conceptual framework for coding data that avoids extremes both of detail and generality. In our project, the coding scheme was developed by isolating the specific research questions for the study and examining each one (separately)

to identify emergent themes. Results across all questions were then examined to identify additional themes across categories (e.g., where seniors discussed a preference for personal contact with medical providers, but relied on internet resources due to lack of contact time with a physician). As few qualitative method texts provide guidance for completing the intellectual work of coding (e.g., the level of specificity needed for theme categories), this model provides strategies for effective iterative coding across multiple transcripts. In the future, this data analysis step for the audio feeds will be combined with an assessment of the video data from the project (i.e., showing seniors' in-context search strategies), in order to point to specific elements of the interface that (for example) slowed the individuals down in their search process or that the seniors regularly selected during the tasks.

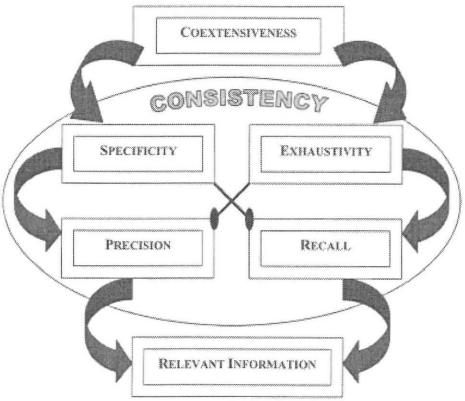

Figure 5. The Knowledge Organization Model as developed by Given and Olson (2003) provides a framework for developing qualitative coding schema, in addition to identifying strategies to manage quantitative and textual data. (Reprinted from *Library & Information Science Research,* Vol. 25, Lisa M. Given and Hope A. Olson, Knowledge Organization in Research: A Conceptual Model for Organizing Data, 157-176, Copyright 2003, with permission from Elsevier.)

One advantage of using this method is that the resulting coded data address very clearly the research questions for the study. Further, it provides a way for researchers to weed through information that is interesting, but not relevant to the project at hand (an ongoing concern for qualitative researchers, who regularly collect very rich data that require substantial time to mine for relevant results). In this way, the same data set can be coded in different ways to represent different research goals, while at the same time isolating specific data points that are of interest; with lengthy interview sessions, this approach saves researchers time by allowing for exhaustive, yet highly focused, analysis procedures. In this study, for example, the interviews and verbal task protocol resulted in an average of 5,000 words per participant, for a total of 60,000 words across 12 participants—a short novel's worth of text.

RESULTS AND DISCUSSION

Interface Comparison

None of the participants were fully satisfied with either the prototype or the www.drugs.com interface, although measures of both performance and preference did favor the rich-prospect browsing prototype. Participants questioned every element of the design process, from the viability of providing online pill information in the first place, to examining the design details of the two interfaces. Insofar as there was a consensus, it might be summarized in the words of Aaron, a 70-year old retired chemist, who at once grudgingly allows some possible benefit to the strategy of rich-prospect browsing, while also pointing out the need for additional data to further subdivide the subsets of pills:

Yeah they both stink. But uh, this one [indicating the prototype] if it allowed you to put in letters or numbers it would be much better. Because it appears as though there's something on each of the pills... I mean you want to do it by um, whatever subdivides them the quickest, and color and shape is not unreasonable, but you're still left with... I mean those grids [of pills sorted by color or size] were roughly a hundred pills.

Search Task Results – www.drugs.com

When searching the www.drugs.com database for information on three different pills, none of the seniors could complete the task and locate information on those pills. Generally, the participants found the interface to be too crowded and confusing and many had a hard time distinguishing between 'drug search' and 'internet search.' The participants were also confused by the descriptions of the pill shapes, as there were no visuals to show the differences between the options (e.g., 'tablet' shape versus 'capsule' shape), and being unable to distinguish between color categories in the search options (e.g.,'black/grey' color combination from the drop down menu was often presumed to mean a pill that was half black and half grey, as opposed to this being a category including pills of both colors). In addition, the online interface for www.drugs.com includes sidebars with drug advertisements, and many of the participants found these drug advertisements very distracting to their search tasks. As Aaron noted at the end of one of his tasks, *"Um... well what do we have to do? Restart this thing? Well it's already turned up no results. At that point I would give up."* Many participants noted that a simpler interface with clearer options and more visuals would have been more efficient and easier to use.

Search Task Results - Prototype

Compared with the www.drugs.com site, most of the participants found the prototype much easier and quicker to use and were able to complete all search tasks. As Vicki, a 66-year-old semi-retired secretary noted, "... this one is easier to use ... because the colors are easier to identify for me. [It's] faster and simpler." Many of the seniors liked the "simpler" interface of the prototype, noting that there was less "guess work" involved in the pill identification. The pill images were described as very helpful and they found the sorting options and tools much easier to use.

However, the prototype design also raised concerns, particularly for those participants who felt "overwhelmed" with the number of pills on screen at one time. Many of the participants found the pills very hard to see and wanted larger images; although the prototype did include a 'zoom' feature, most of the seniors did not see this on screen. Others did not see the 'sort' feature, which would have allowed them to reduce the number of pills by color and/or shape. Reducing the cognitive load and highlighting available search features remains an issue, even in this simpler interface design. In addition, distinguishing between colors was a problem in both the www.drugs.com site and in the prototype. Some of the participants misjudged a pill's color, leading

to a misidentification of drug information. As Martha, a 68-year-old retired social worker, noted, "Well you see, they don't look very orange and brown to me. It looks like a very pale red and an off-white." Distinguishing between similar shapes (e.g., round vs. oval) was also a concern. In any visually based interface, resolution and clarity of images will effect quality of retrieval results. Although sorting by color was frustrating for the one participant in the study who was color-blind, sorting by size was much more efficient for him than in the www.drugs.com interface.

Implications for Design

In general, the rich-prospect browsing interface used for the working prototype showed some advantages over the standard search interface (as modeled in www.drugs.com) for this particular group of users. However, the prototype can be improved in a number of ways, some of which derive from our user feedback and some of which are suggested by principles of interface design. For example, the transitions between the unsorted and sorted versions are currently accomplished by swapping one display for another. Although this is a common method of moving between screens, it can be disorienting and more importantly, it can introduce doubt as to whether all of the pills on the original panel are actually present in the subsequent sorted version. In order to provide some cognitive reassurance, a better strategy suggested by the theory of rich prospect browsing would be to animate the sorting of the pills. If this were done, it would be necessary to explicitly question its effectiveness through subsequent user study. Also, for reasons of technical simplicity, the working prototype used a white background for the pill images. This avoided the need, for example, to use gif formats instead of jpegs, since the transparency on gifs slows loading times for the images. However, since contrast is identified as an important issue for seniors by Strickler and Neafsey (2002), it would be worthwhile to consider developing a variation of the prototype that would allow users to select a colored background. Once again, the specific implementation of the mechanism for increasing contrast would need to be an object of future user study.

The principles of rich-prospect interface design also suggest that it may be useful to look for alternative ways to represent the items in the collection. In this case, the images of the reverse sides of the pills are a natural choice, since in some cases this image contains information that could make the selection process easier. The large number of white, round pills, for example, suggests that the system should provide

additional means for further sub-sorting the pills, including factors such as whether or not the pills have split lines or text. In order to avoid disorienting the viewer, one potential strategy would be to have the interface rotate the pills through an animation that would leave them in place but visually flip them, to show the other side. Lack of contrast within the images (e.g., of the white pills) is another issue which could be addressed through the provision of a third representation. In this way, where the color of a pill makes the embossed or printed text on the pill difficult to read, vector-based drawings of the pills could aid the viewer by allowing the user to enlarge the display without losing definition on the images.

The number of images in the collection is another factor to consider in the design. The current prototype only uses 1000 images; although the upper limits for the underlying database have not been determined, it may be useful to consider strategies for dealing with cases where there are significantly more images. One possibility explored in this study was to provide prospect in the form of a sliding navigation panel across the bottom of the screen, which would visually subset a portion of the entire collection for display in the main panel. However, as the participants of this study identified a number of problems with this potential redesign, further research is needed to examine how best to display large sets of pills in ways that will meet these users' needs.

CONCLUSIONS

In addition to findings related to future redesign of this particular interface, and of areas for further research, this project was particularly innovative in its combination of inclusive design and web usability principles, with a qualitative task-based interview design that allowed seniors to be involved in critiquing existing and potential interface designs. Often, designers create and launch products that leave seniors (and other end-users) to learn how to use the system and to modify their own search strategies to suit the technical limitations of the interface itself. By bringing real end-users in at the early stages of this type of design, revised versions of the interface will be more robust and the end-product will meet these users' specific searching needs. As seniors remain one of the most under-utilized populations for this type of interface design testing, this project also provides useful insight into some of the design 'do's and don'ts' for individuals in the 65 and over age group. With subsequent redesign and retesting (both with other members of this population and with other potential end-users),

findings will transfer across a large sample of people and will lead to a drug information interface that is aesthetically pleasing, easy to navigate and suitable for a variety of health-related information contexts.

FUTURE RESEARCH

As an initial foray into the design of a visually-oriented interface for seniors and as a study designed to put seniors at the forefront of the design process, this project is not only unique but provides useful findings related to inclusive design for older adults. While there are certainly additional design decisions to be made (and additional tests to complete prior to launch), this project provides a solid grounding in seniors' health-related information needs and in the ways that they prefer to search for and locate online information. In addition, the findings of this study point to potential areas of use with other consumers of health information (i.e., younger people; caregivers), as well as individuals working in the health-care sector (e.g., pharmacists; emergency room nurses). By expanding the content and search features of existing drug databases and by developing interfaces that employ inclusive design theory, the opportunities for relevant use of these databases will also grow.

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