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WEB HEALTH INFORMATION ARCHITECTURE FOR OLDER USERS

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ABSTRACT

The present study utilized the card-sorting technique and cluster analysis to define the best information architecture of Web-based health information for older users. Some 16, older computer users participated in the card sorting, 20 in category identification and thirteen in category labeling experiments of 64 health and aging-related Web pages from http://www.dmoz.org. The participants tended to group the items conceptually at higher levels of the hierarchy, but they tended to group the items based on similar words found in the titles at the lower level of the hierarchy. The study also found that user grouping produced more heterogeneous structure than the experimenters' predefined information architecture. Category labels suggested by seniors were observed to be less formal and perhaps more useful than the category labels from http://www.dmoz.org.

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Previous studies have shown that users have various problems accessing information effectively when the user group is not represented in the design team. This is often the case with Web information for older users. Previous studies also found that when the information architecture does not match users' mental model, users will have problems navigating the information structure. One of the ways to incorporate users' needs in information architecture is to employ user-centered design methodologies. The purpose of the study is to utilize the card-sorting technique and cluster analysis to define user-centered information architecture of Web-based health information for older users. Health information was chosen as the tested domain for reasons described below.

HEALTH INFORMATION AND AGING

By the year 2030, people aged 65 and above will represent 20% of US population (US Census Bureau 2000). Older adults are also a rapidly growing segment of the online user population. Until recently older adults have been under-represented as Internet users, but the most generous recent estimate concludes that seniors represent 13% of online users (Cury 2001).

The following estimates depict the current status of older users, relative to their younger counterparts:

- Only 11% of people aged 65 and above are Internet users, compared to the national average of 45% for adults 18 years of age and above (Interep 2000).
- Eighty-seven percent of people 65 and above do not have Internet access and 59% of those between the ages of 50 and 64 do not go online. In comparison, only 35% of those under age 30 do not have Internet access (Lenhart et al. 2000).
- Seventy-four percent of people over 50 who are not online do not plan to get Internet access compared to 35% of those under 50 (Lenhart et al. 2000).
- Forty-five percent of those under 30 believe they are missing out by not being online, while only 26% of those over 64 believe so (Lenhart et al. 2000).

The number of seniors online is expected to increase with the aging of the more computer-literate, baby-boomer population. A Jupiter Communications study shows that the number of seniors online has quadrupled in the past four years—reaching approximately 14 million in 1999 (Strasburg, 2000). A study by eMarketer (http://www.emarketer.com) projected that by year 2003 twenty-seven million people aged 55 and above, or 43% of the population of U.S. seniors, will be active, online users (Allen 2001).

This significant increase in the older, computer-user population has led to various studies investigating how seniors utilize the Web as an information resource. Seniors also increasingly use the Internet for shopping. In 1999, 62% of online seniors made purchases over the Web, compared to 58% for overall adult Internet users (aged 14+). By the year 2003 eMarketer predicts that 78% of online seniors will have made a purchase over the Web (Allen 2001). Seniors also started to use the Internet for financial transactions. One quarter of older Internet users trade equities online, and 19% conduct banking transactions over the Internet (AARP 2000). Of those surveyed, 66% people aged 65 or older said the Internet had made their lives more interesting, and 46% in the same age group said the Net had improved their relationships (Suddenly Senior 2002). In a study that asked older users about their main use of the Internet, the top three answers were for correspondence, accessing news and getting information about health and medical conditions (White et al. 1999; Cochrane 1999).

AARP's Oregon Computer Action Team (1999) summarized these results from several surveys on the computer-usage pattern of senior adults and found the activity as listed in Table 1.

The study also showed that seniors performed more specific computer functions, such as producing memoirs, monitoring investments and tracking genealogy. Some start post-retirement businesses, make greeting cards to send to friends and relatives, and perform legal, recreation, housing, travel, long-term care and medical research using the Internet.

Despite the various online activities that seniors embrace, they still have some disadvantages in effectively utilizing the Internet as an information resource. A recent survey found that a substantial portion of the senior population will never join the Internet community due to disability, technophobia and lack of access (Brink 2000). Older people also have more trouble than younger people finding information in a website (Mead et al 1997). Several websites (mostly commercial) have recognized that older people represent a large and significant role of prospective Internet users, especially because seniors from the middle and upper social-economic status group possess disposable income and free time (Suddenly Senior 2002). Very little research, however, has focused on ensuring that senior-related websites are designed with older users specifically in mind.

Health information on the Internet was accessed by approximately 54 percent of Internet users according to a January 1999 poll (Weber 1999). In 1998, 22 million individuals reported accessing the Web for medical information, with the number estimated to have reached 30 million by 2000 (Elliott and Elliott 2000). However, the existing online health information has not been the most usable by seniors.

Although the medical community is slowly, but cautiously, accepting the Internet as a factor in patient care and doctor-patient relationships, critics report that Internet use by hospital systems and physician groups today is still limited to posting billboards (Cochrane 1999) or to use as a marketing tool

TABLE 1: SENIOR ADULTS COMPUTER ACTIVITIES

Activity	% of respondents
Personal correspondence e.g. e-mail with family and friends	72%
Research a particular issue or subject	59%
Access news	53%
Try the latest adventure games and CD-ROM puzzles	52%
Research travel or vacation destinations	47%
Obtain weather information	43%
Perform volunteer work for various organizations	25%
Source: AARP's Oregon Computer Action Team (1999)	

(Weber 1999). The medical community is generally more concerned with information quality and clinical outcomes arising from usage, rather than with focusing on issues of design for accessibility, usability and accommodation (Winker et al. 2000).

The philosophy of putting emphasis on the accuracy of the information is understandable, given the consequences of inaccurate, incomplete or misused health-related information (Ling 1999). However, without a focused effort on improving accessibility and usability, high-quality information will not necessarily be accessible, and clinical outcomes may not be achievable. Research reviewing medical and health-related websites pointed out that although those sites are attractive, they function only as "yellow pages," i.e., they contain only the names and the phone numbers of their divisions (Cochrane 1999). In addition, it is difficult to find specific information from many sites, and the content is of varying quality (Hersh 1999). Finally, there is a potential for serious abuse and conflict of interest, because of the profit acquired from selling an advertiser's product (Bloom and Iannacon 1999).

For most topics, an inability to find the proper information (or to find the information in a timely manner) might not bring severe consequences. However, the case is different in health and medical areas. Hence, it is crucial to make certain that online health and medical information is structured in a way that would enable users to find the information easily and efficiently.

Previous studies showed that unintuitive Web link labels might lead users to a wrong path or cause disorientation, rendering users unable to find the information (Oliver and Oliver 1996). The aim of this study is to investigate ways to:

1. Create better Web-based health information architecture for seniors.
2. Group and label health information to make it more intuitive for seniors.

THE IMPORTANCE OF INFORMATION ARCHITECTURE

An important step in organizing the content of a website is to place its information according to how individuals typically view information (Bernard 2000b). A well-constructed taxonomy will help end-users locate the desired information quickly and accurately, whereas a badly constructed one might contribute to a considerable waste of time and effort without obtaining the desired information (Karneva et al. 1997).

Rosenfeld and Morville (1998) described in detail the importance of Web information organization, suggesting that the organization of information in websites is of major importance in determining the success of end-users to get the information they need. This organization consists of two aspects: organization structures (the shared characteristics on which the grouping was based on) and organization schemes (the types of relationships between the items and their group). The authors also acknowledged the difficulty in information-architecture design because of differences in the perspectives of users and designers. A structure and scheme obvious to the design team might be completely ambiguous for end-users. (For example, some e-retailers structure their websites according to their organizational structure, unintuitive to unfamiliar users who just want to find the items they need to buy) (Kurniawan 2000).

Furthermore, to make certain that the Web information architecture created by the design team matches users' mental model, there is a need to involve users in various stages of design and development (Bernard 2000a). One of the characteristics of optimal information structure is an information architecture that fits the user's mental model (Lisle, Dong and Isensee 1998). In practice, it means that when designing websites, it is essential to ensure that the information is organized in a way that is meaningful to its target users, as a meaningful information organization will promote efficient navigation (Shneiderman 1997).

USER-CENTERED DESIGN APPROACH

Tuchard and Hass (1998) stated that with user-centered design the usefulness (relevance) and usability (ease-of-use) of websites can be improved, by following the guidelines that in the field of information retrieval and by paying attention to the aspects listed in Table 2.

TABLE 2: ASPECTS TO CONSIDER TO IMPROVE A WEBSITE'S EASE-OF-USE

• User characteristics/demographics • The tasks and goals the users have to accomplish • User's experience and knowledge in computers, the Internet, the information domain and the interfaces • User's environment, hardware and software • The facilitation of user's cognitive processes • Error corrections and recoveries • User's training and learning styles • The types and forms of the information users find the most useful • User's expectations of the system and the interface
Source: Tuchard and Hass (1998)

Shneiderman (1997) discussed the need to improve upon poorly designed computer systems. He noted that this is not just an issue for making computer systems easier to work with. Systems that support life-critical tasks must be reliable and effective. In addition to thinking about the task that the system must perform, the designer must also consider the users' physical abilities and workplaces, personality differences, cultural and international diversity, possible disabilities and issues related to older users. User-centered design is a product of (1) interface designers' careful observation of the way people use computer systems, (2) proper consideration of task frequencies and sequences, and (3) design testing by users and experts throughout the development process. Such design will accommodate the users' skills, goals, and preferences.

Card-Sorting Technique: One of the ways to understand users' perceptions of the relationships among various websites components is to utilize the card-sorting technique. In a card-sorting exercise, participants are presented with randomly ordered cards representing Web pages, and they are asked to group the cards, based on their perceived match with each other (Martin 1999).

Card sorting is considered one of the best usability methods for investigating a user's mental model of an information space (ZDNet Developer 1999). The resulting tree structures can be used as a basis for organizing the

site and for identifying meaningful patterns in the resulting hierarchy that are indicative of general underlying cognitive processes or user mental models.

These patterns can then be generalized to form principles and guidelines for organizing Web content (Karneva et al 1997).

There are two ways to analyze collected data from card-sorting experiments: by "eyeballing" the cards' grouping trend (Martin 1999)—which is tedious for large number of users—or by utilizing the cluster-analysis technique. Cluster analysis of card-sorting data is a promising method for understanding and summarizing multiple participants' input to the organization of websites pages. Cluster analysis quantifies card-sorting data by calculating the strengths of the perceived relationships between pairs of cards, based on how often the members of each possible pair appear in a common group (Martin 1999). The degree of the relationship between any two cards is represented by their similarity score. The output can be displayed as tree diagrams, in which the relationship between any two groups of cards is represented graphically by the distance between the origin and the branching of the lines leading to the two groups.

Website Labeling Systems: Grouping items into categories and determining the hierarchical relationship between categories is only the first step in designing information architecture. Next, all categories and items must be labeled. The labeling system holds as much importance as the information organization. The goal of the labeling system is to communicate information efficiently, without taking too much of either the page's display space and the user's cognitive space. Successful labels mirror the thinking and language of a site's users, not that of its owner (Rosenfeld and Morville 1998).

There are many ways to obtain category labels: by using the search engine's query log, by using generally accepted predefined terms (e.g. subject headings provided by the Library of Congress), or by using experts to represent users (e.g., librarians or information specialists). However, many designers argue that the best way to determine labels is to employ a user-centered methodology by involving a pool of representative users. In this study, a pool of seniors was asked to suggest labels in the exercise called "category identification."

As Rosenfeld and Morville (1998) suggest, after getting the list of terms, there is a need to fine-tune the labeling system to gain consensus and further enhance the label's quality. There are several ways to refine the terms gathered from the aforementioned methods. The best method is to ask a pool of representative users (who should be different from the group that suggested the candidate labels) to pick the best-fitting label for the items in the group. In this study, a different pool of seniors performed the category-labeling experiment.

Nielsen (1999) stated that an effective site structure should reflect the users' view of the site and its information or services. He reported that, in one of his case studies, a common mistake is to have the site structure mirror the institutional organization chart instead of reflecting the user's view of site content. In an e-commerce project, one navigation scheme was structured according to the way most users think about the domain; the other scheme was structured according to the way many of the manufacturer's own staff members thought about their product lines. Results from the usability testing showed that the success rate was 80 percent when people used the navigation scheme structured according to most users' mental model and only 9 percent when they used the navigation scheme structured according to the company's internal thinking (Nielsen 1999).

METHODOLOGY

Participants: The experiment was designed specifically to include a representative pool of the prospective users of the tested health information. Some 16 seniors aged 55 and above (mean age = 68, S.D. = 6 years) participated in the card-sorting experiment (Experiment 1). A different pool of 20 seniors (mean age = 70, S.D. = 13 years) participated in the category-identification, follow-up experiment (Experiment 2). Another new pool of 13 seniors (mean age = 71, S.D. = 8 years) participated in the category-labeling experiment (Experiment 3). All participants lived independently in the community (non-institutionalized), had no visual or cognitive impairment, and had at least 13 years of formal education.

Stimulus Material: The pages used for the card-sorting experiments were 64 leaf items taken from the "Health: Aging" hierarchy of http://dmoz.org/Health/Aging/ website from four main categories: Geriatrics, Diabetes and Alzheimer, Life Cycle and Life Expectancy. The original website structure is pictured in Figures 1-4. Items were carefully selected to be of interest to the participant's age population and of similar title complexity.

Apparatus: 3'x5' Index Cards with the Web link names and short descriptions of the content of Web pages were used in the Card-Sorting test. USort and EZCalc software by IBM™ (Dong and Waldo 2002) were used for the cluster analysis of the card-sorting data. Paper and pencil questionnaires were used for category-identification and category-labeling experiments.

Experiment 1 Card sorting: The link title and a short description of each of the 64 Web pages were printed on 64 index cards. An example of index card is depicted in Figure 5. Each participant was given one set of sixteen (16), randomly ordered index cards from one of the four dmoz main categories. The

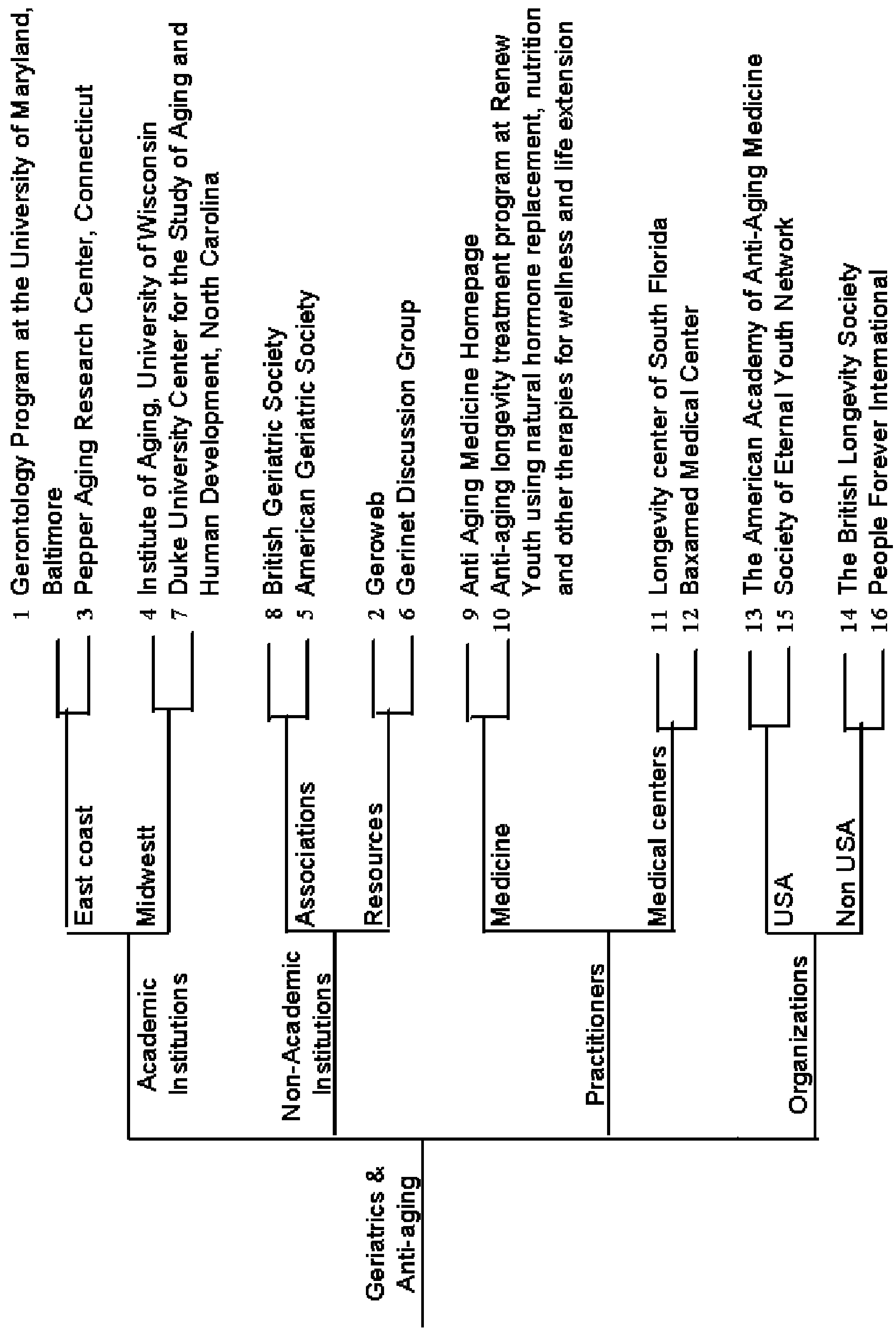

FIGURE 1: THE DMOZ HIERARCHY FOR THE GERIATRICS AND ANTI-AGING CATEGORY

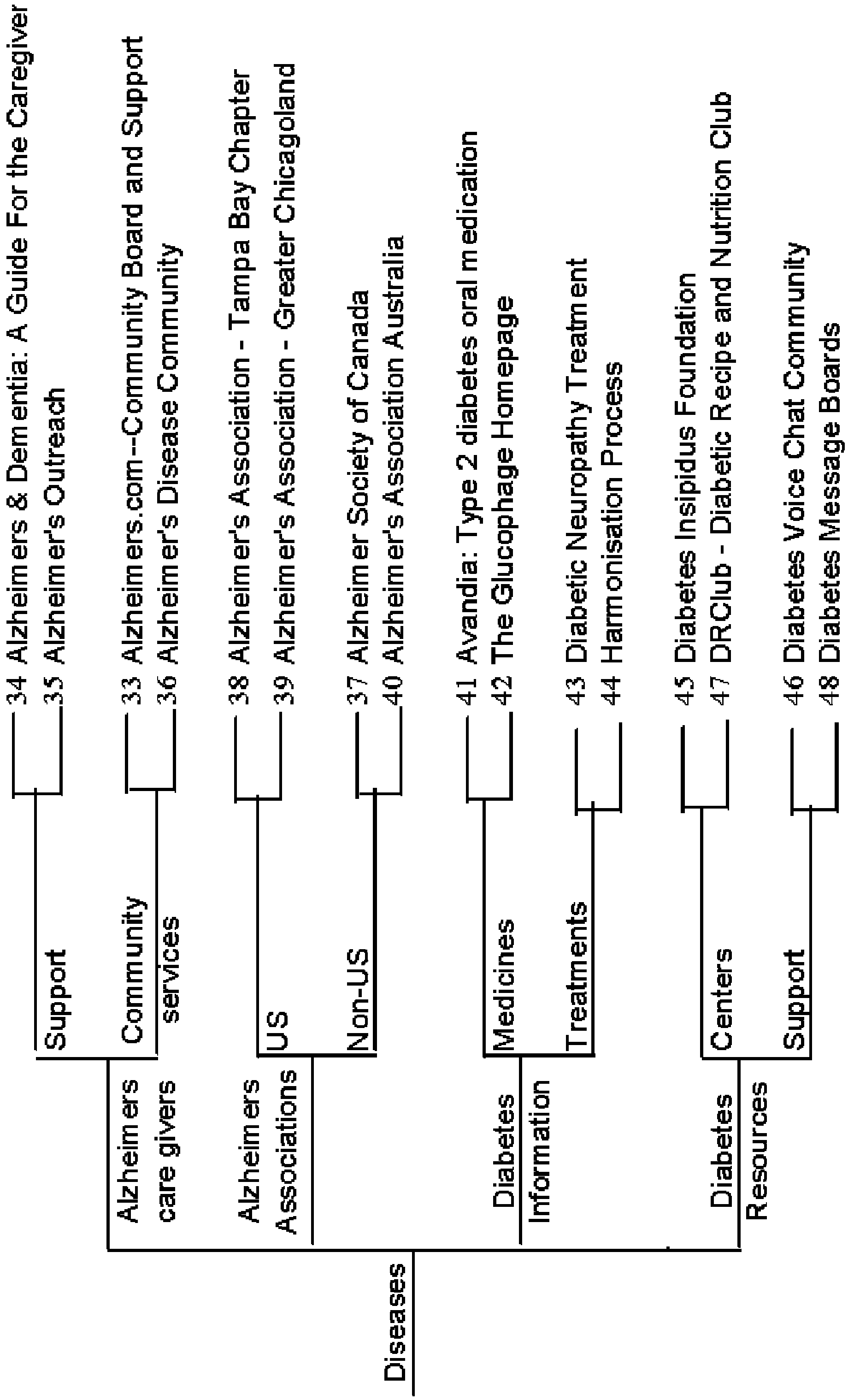

FIGURE 2: THE DMOZ HIERARCHY FOR THE DISEASES CATEGORY

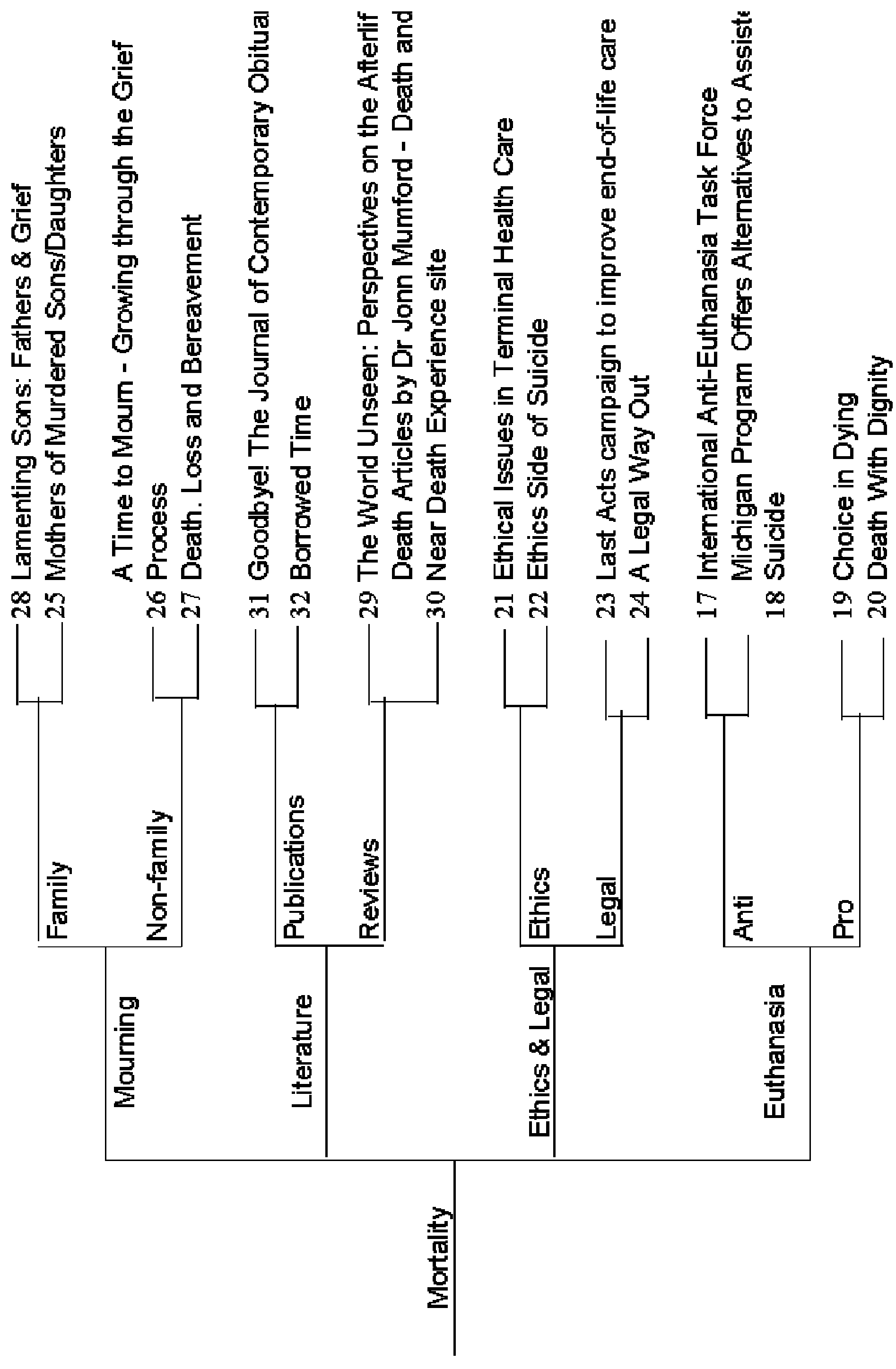

FIGURE 3: THE DMOZ HIERARCHY FOR THE MORTALITY CATEGORY

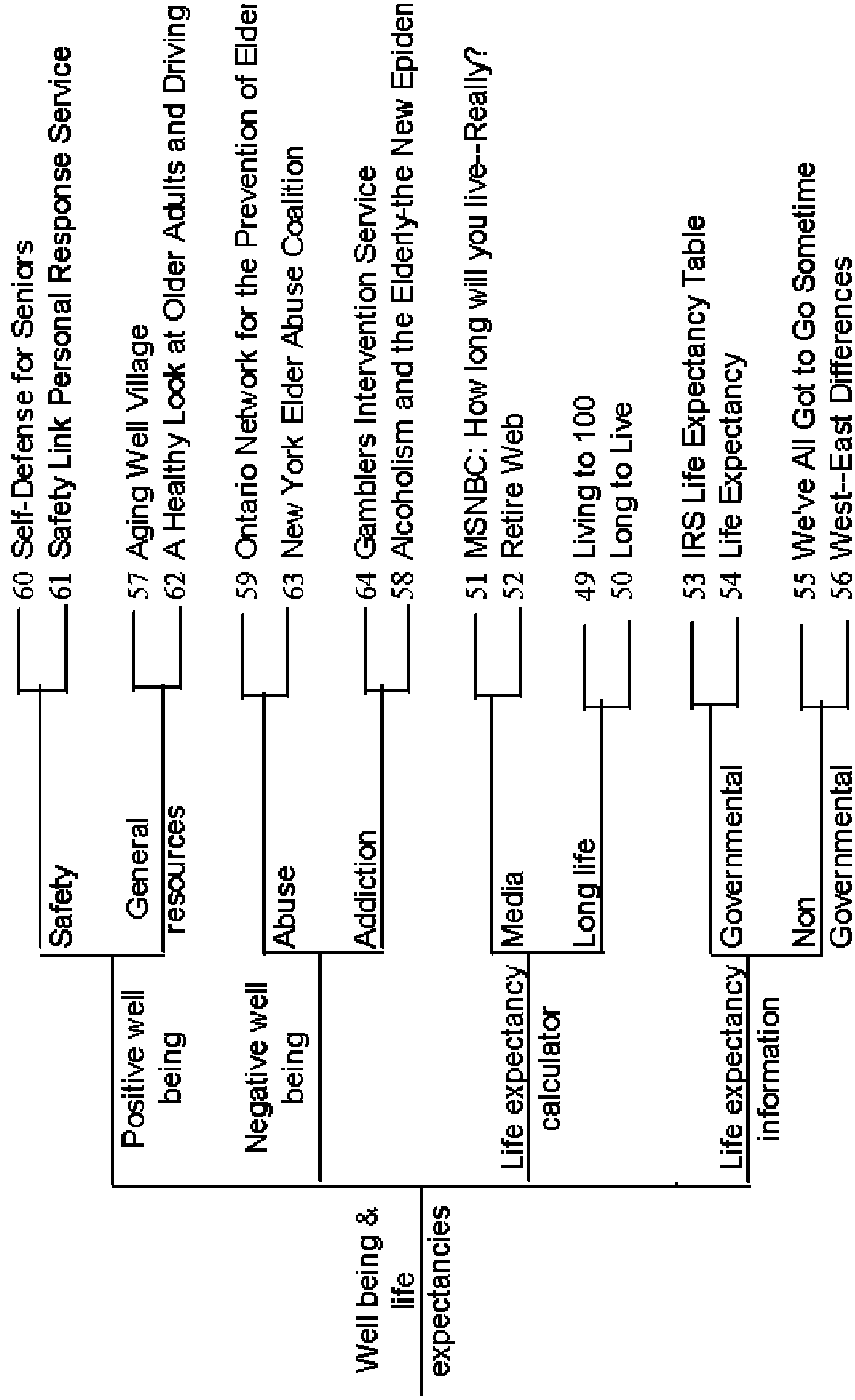

FIGURE 4: THE DMOZ HIERARCHY FOR THE WELL-BEING AND LIFE-EXPECTANCY CATEGORY

FIGURE 5: AN EXAMPLE OF INDEX CARDS USED IN THIS EXPERIMENT

Alzheimer's Outreach Information for caregivers of Alzheimer's patients and caregivers. Includes message board, poetry and numerous places to relax.

participant was tested in an individual session to make sure that the grouping was based on individual observation rather than group observations.

The participants were asked to sort the cards into logical groupings according to the following instructions (ZDNet Developer 1999) that were read to them:

- Please sort these cards into piles so that things that you think go together are in the same pile.
- You can have as many or as few piles as you like.
- The piles do not need to contain the same number of cards: some piles may be very big and others may have one or two cards if you don't think they are sufficiently similar to others.
- You can change your mind and move cards around and merge or split piles as you go.

When participants were comfortable with their final sorting arrangement, they were asked to record their card groupings on paper. To aid in understanding each participant's underlying mental model of how items grouped together, the participant was asked to write down suggested group labels and a short description of reasons for the grouping. Each participant was then asked to repeat the experiment using a different grouping strategy.

If participants found an item that they couldn't group with any of their current groups, they were given two options: 1) either place the item in any of the existing categories or 2) list the item as a separate group with the item's name as the group name (some help was provided by asking the participants to use the "thinking out loud" method while creating the categories). In cases where the participants felt that some items could fit into more than one group, they were allowed to list that item in one or more categories.

A cluster analysis was then conducted using EZCalc software across all participants' card groupings to produce the final hierarchical structures. The thresholds of the cluster analysis were chosen to create four, second-level options for each of the main categories to match the original architecture; this enabled both a visual and a future empirical comparison between the userdefined and dmoz architectures. Category identification and category labeling are follow-up experiments to card sorting. These experiments help to ensure that the content categories and labels also match user's mental model.

Experiment 2: The category identification. In this experiment each participant was given paper printouts containing items that were suggested to belong to the same group by the participants of Experiment 1. Each participant in Experiment 2 was then asked to write down a suggested label for each of the groups. In general, across the twenty participants, 3–5 names were proposed for each group.

Experiment 3: The category labeling. Category labeling involved presenting users with the category labels suggested by the participants of Experiment 2 and the items that belong to that category. Each participant was then asked to rank the suggested labels based on their fit to the group (lower number means higher fit). The numbers were then added up and the label with the smaller sum was the chosen label for the group. The final hierarchical information architectures are depicted in Figures 6-9.

RESULTS

The plots revealed that, through the use of user feedback, the information architecture 'designed' by the older users was different from the original structure. The original homogeneous (four items per branch) design selected by the experimenters from the dmoz site was transformed to a heterogeneous hierarchy (ranging from two to six items per branch).
Another interesting observation was that the participants tended to group items conceptually at the higher levels of the information structure (e.g., by putting items related to Organizations or Diabetes in one group), but they tended to be influenced by common words found in link name titles (e.g., "Longevity" or "Anti-aging") when they grouped items at the lower level of the hierarchy. In contrast to the predefined grouping, where the information was often grouped based on geographic location (e.g., Research Institutions in US versus Research Institutions abroad), these senior participants tended to group items according to their functionality or service provided (e.g. Aging-related Institutions; Research Centers about Diabetes).

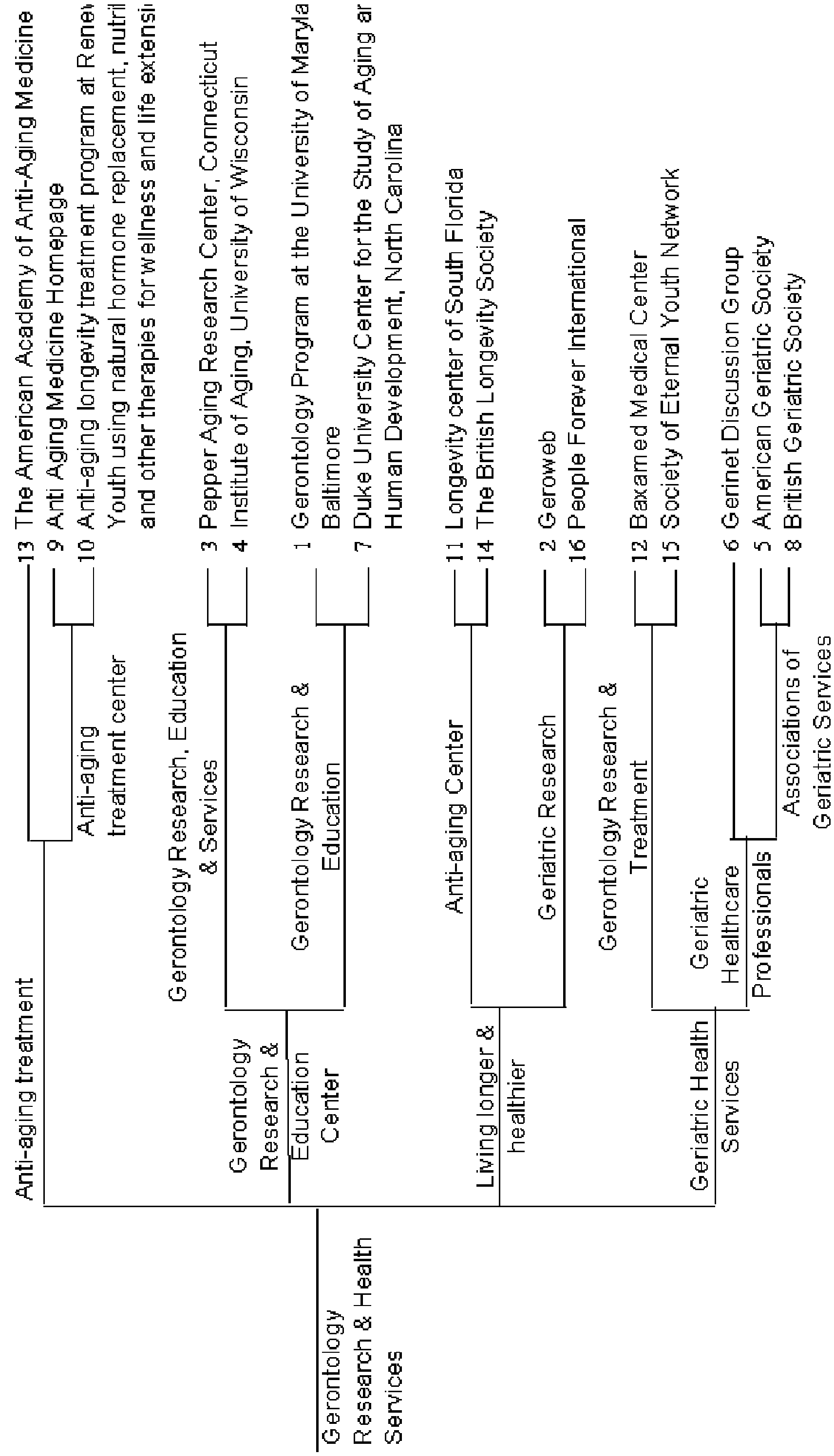

FIGURE 6: THE SENIOR-DEFINED HIERARCHY FOR THE GERIATRICS AND ANTI-AGING CATEGORY

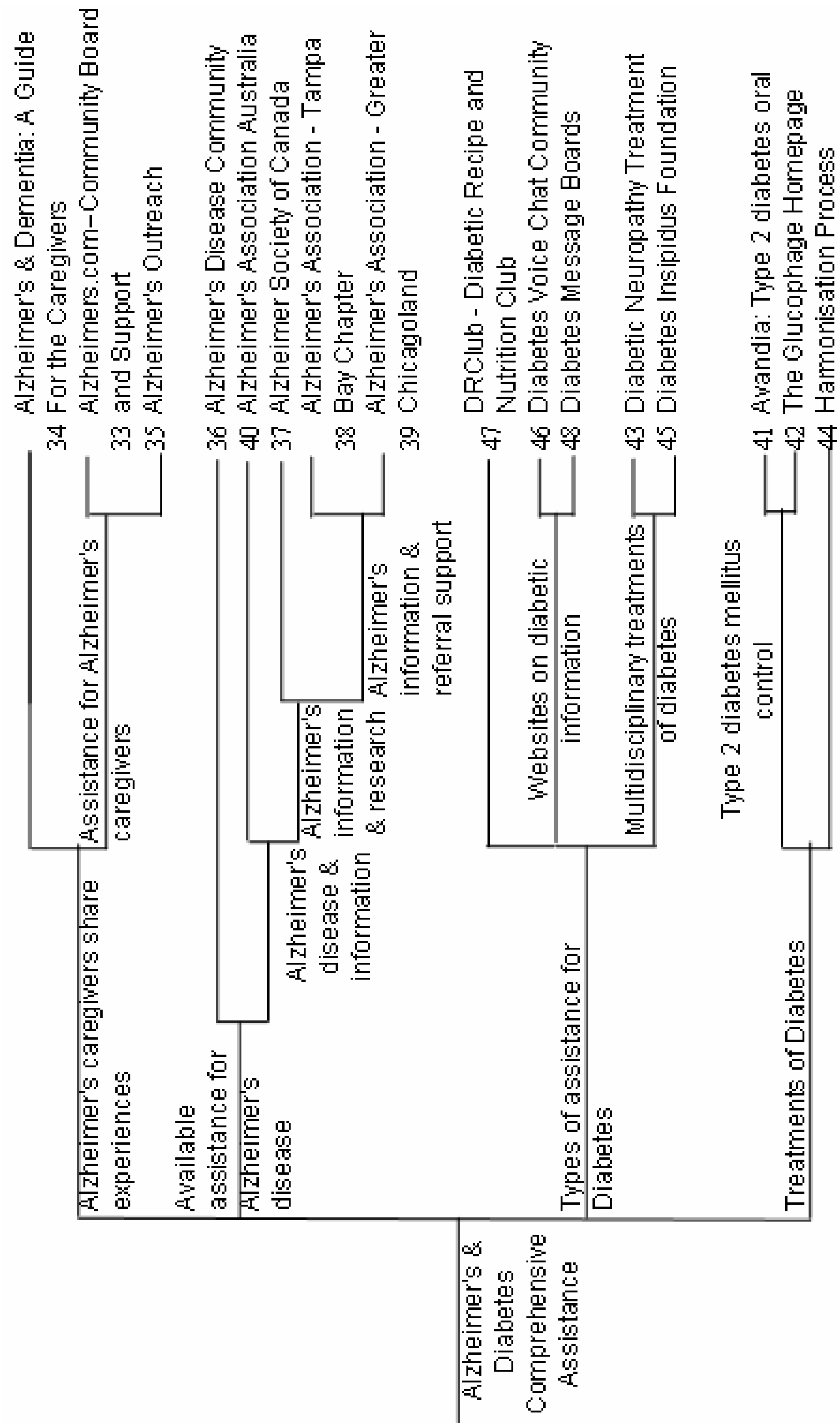

FIGURE 7: THE SENIOR-DEFINED HIERARCHY FOR THE DISEASES CATEGORY

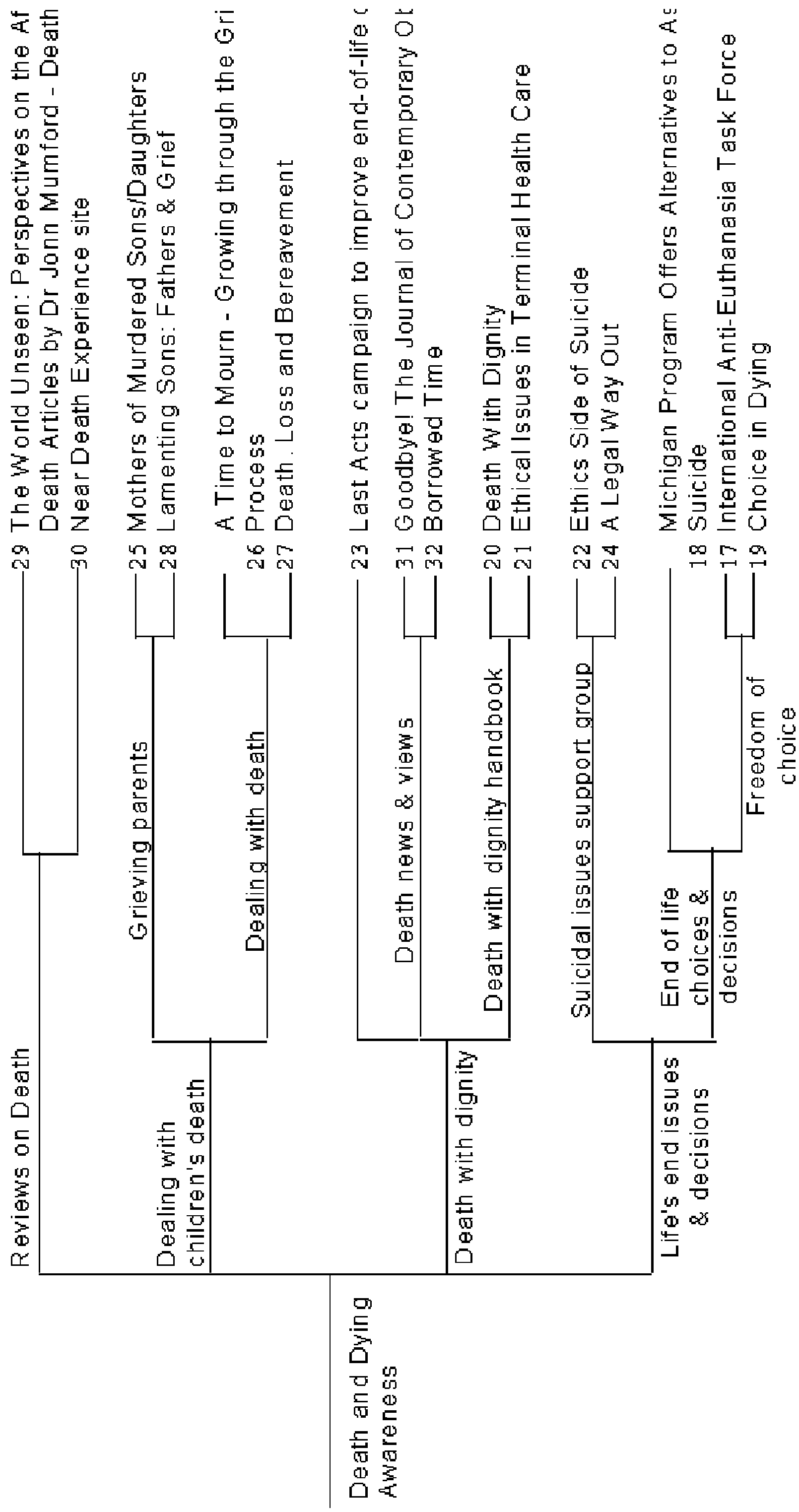

FIGURE 8: THE SENIOR-DEFINED HIERARCHY FOR THE MORTALITY CATEGORY

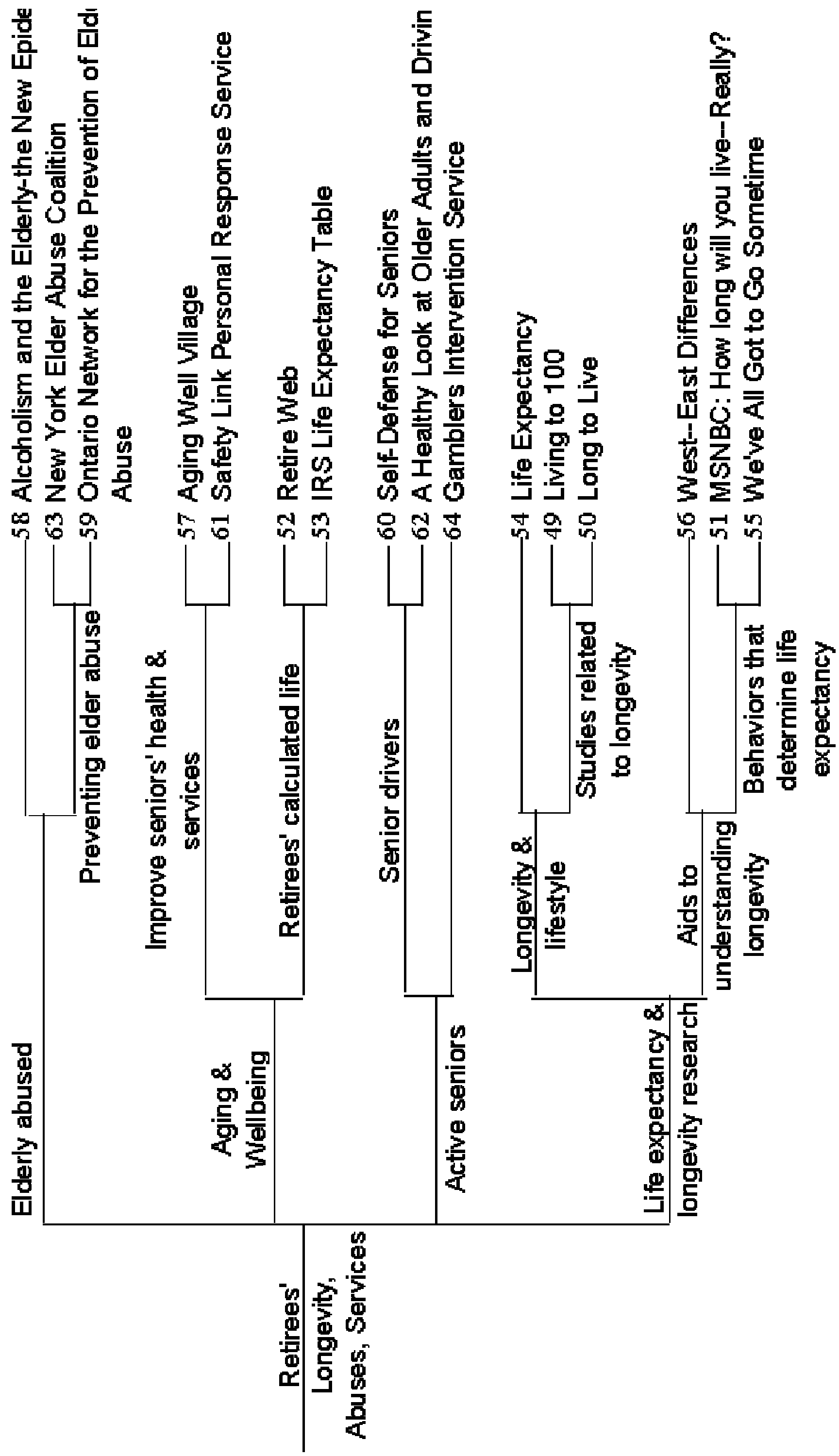

FIGURE 9: THE SENIOR-DEFINED HIERARCHY FOR THE WELL-BEING AND LIFE-EXPECTANCIES CATEGORY

The participants in the category-labeling experiment suggested new labels for the proposed categories. These labels were less formal than the category labels designed by the experimenter and/or http://www.dmoz.org. For example, http://www.dmoz.org used labels such as "positive well-being" or "life expectancy calculators" while the participants suggested "elderly abused" or "active seniors". One could argue that these category labels match the user perception better than the predefined information architecture, a claim deserving further study.

CONCLUSIONS

This study applied a series of user-centered design exercises to build senior-oriented, information architecture for health-related information on the Web. Previous studies (e.g. Kurniawan, Ellis and Allaire 2002) on bookmark manipulation found that older people are as active as their younger counterparts in organizing their personal information. Therefore, there is a need to put enough effort to facilitate a way to enable older Web users to organize their information.

The results of this study showed that involving prospective users in the design can capture users' underlying perceptions of different components of the information architecture, including the structure and the labels of the hierarchy. The resulting information architecture can be expected to be more user-friendly, because its design is a closer fit to user's mental model, although this needs further investigation.

The study suggests that Web designers should accommodate the needs of users to ensure that their products would be more useful and usable for the end-users. More generally, with the Internet being more integrated in various aspects of life, it is necessary when designing the online information architecture to accommodate users with different characteristics—this includes people with disabilities, older users, and people with limited computer/Internet knowledge. Accommodating diverse users may facilitate easier access routes so that as many people as possible can take full advantage of the Internet/ computer technology. This may be the first step in reducing the digital divide.

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