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ABSTRACT

Although the Net is an indispensable business/personal tool for many, indications are that a growing population chunk – the Alzheimer's afflicted – will be unable to harness it due to inappropriate interface design. By 2050, over 80 million will exceed age 65, the Worker/Retiree ratio will shrink to 2, and the number of Alzheimer's Disease (AD) patients will triple to 14 million. Annual estimated societal costs attributable to AD are about $100 billion with no cure in sight. Simultaneously, more Americans must remain productive post retirement age and non-retirees are increasingly being diagnosed with AD. The socio-economic ramifications are tremendous. The World Wide Web Consortium (W3C) and Congress have advanced guidelines/laws to make IT more disabled friendly. However, a fundamental issue remains: to our knowledge, the guidelines are entirely prescriptive and we are unaware of rigorous research evidence demonstrating benefits to compliance. Our work focuses on specific aspects of this research opportunity.

Keywords

Alzheimer's Disease, Accessibility, Disabled, UAWG 1.0, Rehabilitation Act - Section 508.

INTRODUCTION

The National Institute of Aging estimates that up to 4 million Americans suffer from AD (Alzheimer's Disease Education and Referral Center, 2004). The number afflicted is expected to triple to 14 million by the year 2050. The estimated total annual societal costs attributable to AD are about $100 billion (President and Fellows of Harvard College, 2002). The socio-economic ramifications are tremendous. Given this grim scenario and the peculiar cognitional degenerative characteristics of AD, it is essential that AD patients receive especially-tailored care and facilities to enhance both the quality of care received and their quality of life.

IS developers have hitherto focused largely on the development of interface designs meant for the young and the healthy. Thus, despite the national proliferation of internet access for business and non-commercial use, we are quite likely to face an unprecedented "intra-national digital divide," one where a significant, growing population chunk is isolated from effectively harnessing the Net due to inappropriate interface design. Apart from its personal and professional uses, we believe that the Net is a potentially useful AD patient-care tool, one that offers a venue for the AD-afflicted to keep themselves mentally engaged/productive and one that is a means for realizing a primary objective of patient care, viz., "resurrecting the self."

We believe that the development of "Alzheimer friendly" interface designs is of paramount importance and this is the ultimate end product that we envisage from our research. Simultaneously, we hope to spearhead a research pathway that we, and others, can follow in the future to enhance our early efforts and extend it to other domains.

THEORY DEVELOPMENT, RESEARCH MODEL AND HYPOTHESES

Prior research on cognitive processes, perceptions, and performance (McGraw, 1994) suggests that systems based on a user's Mental Model, Knowledge Structures and Work Processes tend to be more "user friendly." Three key elements of Web interface design that influence user perceptions and performance are the Navigation Structure (NST) (Holsapple and Fang, 2002, 2003; McDonald, 1998), Content Compatibility (CCP) (Chau and Hu, 2002; Chen, Gillenson and Sherrell, 2002) of the web page and the Knowledge Acquisition Task (KAT) (Holsapple and Fang, 2000, 2002; McGraw, 1994) being performed. From a technical perspective, Web interface design deals with three inter-related dimensions: Usability, Visualization, and Functionality (Vertelney, Arent and Lieberman, 1989). Usability refers to how intuitively a user can navigate a system. Visualization refers to creating visually interesting, aesthetically pleasing interfaces while avoiding potentially distracting elements. Functionality pertains to the usefulness of the interface in supporting a task. More recently, a fourth dimension, Accessibility, has been created with the objective of improving web access by those with visual, hearing, physical, cognitive, and neurological disabilities (W3C, 2002a). The W3C has advanced the UAWG 1.0 guidelines (W3C, 2002b) and the US Congress has enacted the Rehabilitation Act-Section 508 (Architectural and Transportation Barriers Compliance Board, 2000) towards meeting this objective. However, these guidelines are prescriptive. To our knowledge, they are not theoretically grounded nor have they been experimentally validated.

Our work seeks to extend existing theory on the impacts of the three design dimensions of Usability, Visualization, and Functionality on user cognition/perception/performance among the healthy to the case where Accessibility is part of the picture and the focus is on the AD afflicted. A common characteristic of all Alzheimer's patients is progressive memory loss and associated cognitive and learning degeneration. Based on this, the Harvard Health Publications Special Report (President and Fellows of Harvard College, 2002) classifies patients into five stages depending on the extent of progression of the disease.[1] Given the differentiating characteristics of AD, our interest lies in the cognitive-processing-related Accessibility factors. Part 1 of the study will examine the three categories of KAT, NST, and CCP of traditional web interface designs in isolation and in various combinations. The intent is to help establish one or more "base" websites that contain essential features of "traditional" web design for our purposes but which are UAWG 1.0/Section 508 non-compliant. In Part 2, we modify these base sites to develop websites that are compliant to one extent or another. We contrast the modified and base web sites to see whether compliance does result in significantly better subject perceptions and performance.

Part 1 - Evaluating KAT, NST and CCP elements

Hypotheses 1 (Knowledge Acquisition Task-Related)

Anderson (1990) classifies knowledge as being "declarative" and "procedural." Declarative Knowledge (DK) refers to factual knowledge. Procedural Knowledge (PK) refers to knowledge concerning the execution of a particular process. We extend Anderson's definitions of knowledge types to tasks that we term Declarative Tasks (DT) and Procedural Tasks (PT). A DT is one that involves the acquisition of a piece of DK. A PT involves both the acquisition and the use of PK to create a piece of DK. Thus, a PT is more complex than a DT. With the implementation of tasks that meet these definitions, the following hypotheses can be tested:

> H1a: *All else being constant, performance declines with increasing AD stage index for both DT and PT.*
> H1b: *All else being constant, performance with DT exceeds that with PT at a given AD stage index.*

Hypotheses 2 (Navigation Structure-Related):

According to the Mental Model Theory (Craik, 1943), mental models are primarily representations of reality constructed in one's mind. When navigating a web site, a mental model of the navigation structure is created that helps efficient navigation from page to page. We focus on two navigation structures, the Hierarchical (HR) and the Network (NW). HR denotes a linear structure wherein each link on the home page leads to a set of logically-grouped sub-level pages. There are no cross-referential links between sub-level pages within a set or across sets. To access one sub-level page from another, a user must traverse the hierarchy. An NW structure permits cross-referential links between sub-level pages. As an Alzheimer's patient advances along the AD stages, we expect increasing deterioration of prior mental models and greater difficulty with creating

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[1] We expect our work to encompass patients diagnosed as being at stages 1 through 3 (individuals beyond Stage 3 may be medically unable to participate).We may also attempt to refine this 5-stage categorization scheme using the Kit of Factor-Referenced Cognitive Tests (Ekstrom, French and Harman, 1979)

new mental models. As such, the non-linear accessibility of NW should result in better performance than the linear HR, particularly as the number of pages to be traversed increases.

> H2a: *All else being constant, performance declines with increasing AD stage index for both NW and HR.*
> H2b: *All else being constant, performance with NW exceeds that with HR at a given AD stage index.*

Hypotheses 3 (Content Compatibility-related)

Prior research (Chau and Hu, 2002; Chen, Gillenson and Sherrell, 2002) indicates that positive user perceptions result when interface content matches a user's values, beliefs, and past experiences. Alzheimer's patients have been observed as experiencing heightened enjoyment and total immersion in activities associated with their past (President and Fellows of Harvard College, 2002). We have two categories of Content Compatibility, Compatible (CO) and Incompatible (IC). Unlike an IC interface, a CO interface has content material that has relevance and meaning in light of a subject's past experiences.

> H3a: *All else being constant, performance declines with increasing AD stage index for both CO and IC.*
> H3b: *All else being constant, performance with CO exceeds that with IC at a given AD stage index.*

Based on the above, we also expect the following hypotheses to hold:

Hypotheses 4 (Knowledge Acquisition Task x Navigation Structure-related)

> H4a: *All else being constant, there will be a decline in performance with increasing AD Stage index at any given KAT x NST setting.*
> H4b: *All else being constant, performance will be strongest with a DT x NW setting and weakest with a PT x HR setting at a given AD stage index.*

Hypotheses 5 (Knowledge Acquisition Task x Content Compatibility-related)

> H5a: *All else being constant, there will be a decline in performance with increasing AD Stage index at any given KAT x CCP setting.*
> H5b: *All else being constant, performance will be strongest with a DT x CO setting and weakest with a PT x IC setting at a given AD stage index.*

Hypotheses 6 (Navigation Structure x Content Compatibility-related)

> H6a: *All else being constant, there will be a decline in performance with increasing AD Stage index at any given NST x CCP setting.*
> H6b: *All else being constant, performance will be strongest with a CO x NW setting and weakest with an IC x HR setting at a given AD stage index.*

Hypotheses 7 (Knowledge Acquisition Task X Navigation Structure X Content Compatibility-Related)

> H7b: *All else being constant, there will be a decline in performance with increasing AD Stage index at any given KAT x NST x CCP setting.*
> H7a: *All else being constant, performance will be strongest with a DT x CO x NW setting and weakest with a PT x IC x HR setting at a given AD stage index.*

We expect the outcomes of the above battery of tests to point us toward one or more web-site designs that have particular KAT, NST, and CCP characteristics but are non-compliant. In Part 2, we progressively perturb these base designs to see to what extent UAWG 1.0/Section 508-compliance further enhances performance with each design.

Part 2 – Evaluating UAWG 1.0/Sec 508 Guidelines

This portion is aimed at gauging the effectiveness of the UAWG/Sec 508 compliance in fostering enhanced accessibility and consequent performance improvement among Alzheimer's patients. Currently, there are twelve UAWG 1.0 guidelines each composed of a set of checkpoints. Each checkpoint is associated with one of three priority levels (P1, P2, and P3) indicating its relative importance. As the level of compliance progresses from P1 to P3 the accessibility/performance level should

increase.[2] We wish to test whether increasing compliance results in enhanced performance and, hence, the following hypothesis:

> H8: *All else being constant, performance increases with increasing compliance Priority Level index at a given AD stage index.*

EXPERIMENTAL DESIGN ISSUES

Performance Measures

Perceptual: Perceptual measurements are taken using the Technology Acceptance Model's (Davis, 1993) "perceived ease of use" and "perceived usefulness" constructs adapted for use with AD patients. Additionally, suitable measures from the Kit of Factor-Referenced Cognitive Tests (Ekstrom, French and Harman, 1979) may be used.

Non-perceptual: Non-perceptual measurements pertain to actual user performance and encompass three dimensions: task "completion success" (yes or no), the "navigational efficiency" of task performance (quality of navigational paths chosen to terminal state vis-à-vis the optimal path to successful task completion), and (3) the "time efficiency" of task performance (time taken to arrive at terminal state vis-à-vis the optimal time for successful task completion).

Experimental Design

We use a Randomized Complete Block Design with four blocks pertaining to the first three disease stages and a healthy control group. The design would permit comparison within a disease stage and across stages. Identical treatments are randomly assigned to the blocks. We expect the randomization procedure to largely account for individual differences that could confound the treatment effects.

Experimental Platform

Experimental platform hardware will be compatible in all respects. All of the interface designs (treatments) will be developed using identical coding techniques but will not use color, sound, video, and other multimedia effects that could confound the treatments of interest. Our design treatments will be saved on local hard drives for local access, thus eliminating network- and time-specific confounds.

CONCLUDING REMARKS

We provided a brief overview of a theoretically-grounded, statistically-rigorous experiment involving an assessment of website accessibility by the Alzheimer's afflicted. We attempt to build upon the existing base of Interface Design research by drawing upon the UAWG 1.0 and Section 508 accessibility-related guidelines. Our long-term objective is to help initiate a concerted effort from the Information Systems research community toward contributing to the enhancement of the quality of life of, and thus the care provided to, Alzheimer's patients. However, we do believe that our findings would have application potential to other groups with cognitive and memory disabilities and that some or all of our findings could contribute to user interface design, in general. Our Research-In-Progress presentation will summarize the above issues and also provide further platform operationalization details and pilot-test findings.

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[2] The Sec 508 guidelines form a subset of the UAWG guidelines and, hence, may be integrated within the latter's 3-level prioritization scheme.

REFERENCES

1. Alzheimer's Disease Education and Referral Center. (2004) General Information, Retrieved 02/01/04, http://adear.niapublications.org/generalinfo.htm
2. Anderson, J. (1990) The Adaptive Character of Thought, Erlbaum Associates.
3. Architectural and Transportation Barriers Compliance Board. (2000) Electronic and Information Technology Accessibility Standards, Retrieved 02/01/04, http://www.access-board.gov/sec508/508standards.htm
4. Chau, P. and Hu, P. (2002) Examining a model of IT acceptance by individual professionals: An exploratory study, *Journal of Management Information Systems*, 18, 4, 191-229.
5. Chen, L., Gillenson, M.L. and Sherrell, D.L. (2002) Enticing online consumers: an extended technology acceptance perspective, *Information & Management*, 39, 8, 705-719.
6. Craik, K. (1943) The Nature of Explanation, Cambridge University Press.
7. Davis, F.D. (1993) User acceptance of information technology: system characteristics, user perceptions and behavioral impacts, *International Journal of Man-Machine Studies*, 38, 3, 475-487.
8. Ekstrom, R. B., French, J. W. and Harman, H. H. (1979) Cognitive factors: Their identification and replication, *Multivariate Behavioral Research Monographs*, 79, 2.
9. McDonald, S. (1998) Effects of text structure and prior knowledge of the learner on navigation in Hypertext, *Human Factors*, 40, 1, 18-28.
10. McGraw, K. (1994) Knowledge Acquisition and Interface Design, *IEEE Software*, 11, 6, 90-92.
11. Holsapple, C.W. and Fang, X. (2000) Toward a Knowledge Acquisition Framework for Web Site Design, *Proceedings of the Americas Conference on Information Systems 2000*, Long Beach, CA.
12. Holsapple, C.W. and Fang, X. (2002) An Experimental Study of Web Site Usability for Alternative Navigation Structures, *Kentucky Initiative for Knowledge Management*, 163.
13. Holsapple, C.W. and Fang, X. (2003) The Usability of Web Sites for Knowledge Acquisition: A Taxonomy of Influences, *International Journal of Electronic Business*, 1, 2, 211-224.
14. President and Fellows of Harvard College (2002) A Guide to Alzheimer's Disease, A Harvard Health Publications Special Report, Harvard Health Publications Group, Boston.
15. Vertelney, L., Arent, M. and Lieberman, H., (1989) Two Disciplines in Search of an Interface: Reflections on a Design Problem The Art of Human-Computer Interface Design, B. Laurel (ed), Addison-Wesley.
16. WWW Consortium. (2002a) Summary of User Agent Accessibility Guidelines, Retrieved 02/01/04, http://www.w3.org/TR/UAAG10/uaag10-summary.html.
17. WWW Consortium. (2002b) User Agent Accessibility Guidelines, Retrieved 02/01/04, http://www.w3.org/TR/UAAG10/guidelines.html#Guidelines