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FLUID AND CRYSTALLISED INTELLIGENCE IN ELDERLY PEOPLE: DESIGN GUIDELINES TO IMPROVE WEB USABILITY

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A RESEARCH REPORT SUBMITTED TO THE WITS SCHOOL OF ARTS, FACULTY OF HUMANITIES, UNIVERSITY OF THE WITWATERSRAND IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS BY COMBINATION OF COURSEWORK AND RESEARCH

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ABSTRACT

There is a steady growth in the elderly demographic. These older people have various informational needs, and the internet plays an influential role in catering to their needs. Given the advantages that the internet offers the number of elderly adults adopting technology has not risen significantly. Understanding how age affects technological use and determining how to design technical products will assist in improving technology ratification and usage among elderly people.

Cognitive ability plays a significant role in information retrieval on web interfaces. The aim of the research is to understand the theories around fluid and crystallised intelligence in relation to information retrieval when using technology. The study intends to discuss the implications of information organisation on information retrieval when elderly adults use web interfaces. The research then proposes an information architecture aimed at older adults.

This research is qualitative. The theoretical framework which formed the basis for understanding the theory of fluid and crystallised intelligence in relation to information retrieval from web interfaces helped in understanding the two information organisations namely hierarchical and tag-based. The proposed alphabetically arranged combination of tag-based and hierarchical system formed the basis for con-

ducting semi-structured interviews and tracking user interactions with elderly users. The research used National Institute of Health-Senior health (NIH) and South African Tourism (SAT) websites for semi-structured interviews with elderly people.

The interview data was analysed using thematic content analysis. The observation of the users and the analysis of interview data proved that an alphabetically arranged combination of tag-based and hierarchical system was simple to use for elderly users. Design guidelines were then formulated for web interfaces featuring Crystallised Intelligence enhancing the process of information retrieval by elderly adults.

DECLARATION

I Shubapradha Ravi declare that this Research Report is my own, unaided work. It is submitted for the degree of Master of Arts at the University of the Witwatersrand, Johannesburg. This work has not been submitted before for any degree or examination in any other University.

Signature: Shubapradha

Date: 26-06-17

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CHAPTER 1: INTRODUCTION

1.1 Background to the Problem

We are experiencing two sociocultural trends. The first being an increase in longevity which has led to an ageing population. Figures from the United Nations, Department of Economic and Social Affairs show an increase in the elderly population and that by 2050, there will be more people aged 60 and above (2.1billion) than children under 15 years. Between 2015 and 2030, the number of individuals in the world aged 60 years and above is expected to grow by 56 percent (1-26). The second being an accelerated growth in microprocessor technology which has a significant effect on improving productivity and well-being. The confluence of these two trends might either lead to beneficial outcomes for an ageing population or may create a digital divide among the elderly people and the younger generation (Charness and Boot 253).

Research indicates that although there has been an increase in the use of technology by elderly people, they have more difficulty than younger people in learning to use technology (Czaja et al. 333).

The information needs of the elderly as pointed by Dinet and Vivian in “Elderly People as Web Seekers: Needs, Strategies and Difficulties” include finance, health, community care, housing, leisure, repairs done at home, buying something for home and practical help. The internet helps in information retrieval and thereby taking care of the informational needs of the elderly (390-392). The use of the internet plays a major role in improving the quality of life of the elderly. It additionally helps establish and maintain social relations, which improves mental and physical health and hence protects them from social isolation (Boz and Karatas 182-191). As Brown in “Self-esteem and Life Satisfaction of Aged Individuals with and without Access to Computer Training” points out that cognitive competence, personal identity, level of dignity, perceived independence, efficiency and adaptability; control, autonomy, social competence, self-efficacy or self-mastery and optimism-pessimism are some of the psychological factors that determine the quality of life of the elderly people (8-11).

1.2 Statement of the Problem

Ageing is associated with cognitive changes, which makes designing of interfaces for the elderly people a challenge. The knowledge and understanding of the change in cognitive abilities of the elderly help when designing suitable web interfaces; which results in ease of access to information on the interface. Cognitive ability involves the processing of mental information for the successful completion of a task. A broad way to organise cognitive ability is the Cattell, Horn and Carroll theories of fluid and crystallised intelligence. Crystallised intelligence refers to the knowledge that is acquired over a period, for example, vocabulary, while fluid intelligence refers to problem-solving in novel situations and reasoning.

The aim of the research is to understand the Cattell, Horn and Carroll theories of fluid and crystallised intelligence in relation to information retrieval and problem-

solving when using technology. I intend to discuss the implications of information organisation on information retrieval when elderly adults use web interfaces. I will then propose an information organisation aimed at elderly people. From the criteria to be outlined in a better understanding of the fluid and crystallised intelligence, I will conduct interviews with elderly people to understand whether these concerns apply to them when using web interfaces namely the South African Tourism website and the National Institute of Health - Senior Health website. Based on the findings of the interview and in relation to Cattell, Horn and Carroll theories I intend to formulate design guidelines for an improved web interface based on the proposed information organisation. These design guidelines will then be the basis to investigate, evaluate and compare the South African Tourism website and the National Institute of Health - Senior Health website respectively.

1.3 Research Questions

Crystallised Intelligence of elderly adults has direct influence on information retrieval on web interface, meaning that the interface with active information organisation which uses Crystallised Intelligence will provide better access to information thereby ensuring ease of use by elderly users (Pak and Price).

The following research questions will be answered:

1. What are the effects of ageing on motor, sensory and cognitive abilities?
2. What are the barriers for the use of technology by the elderly people?
3. What does one mean by the term cognitive ability and cognitive process?
4. What is the relationship between information retrieval and information organisation?

5. Is an alphabetically arranged combination of tag-based and hierarchical system beneficial for elderly adults?

The research questions one, two, three and four will be replied through literature review. The research question five will be answered through semi-structured interviews with the elderly participants. The data received from the semi-structured interviews will be analysed using Thematic Data Analysis technique.

1.4 Objectives of the Study

The overall purpose of the study is to determine if the cognitive abilities of elderly adults have consequences on information retrieval from web interfaces. Understanding and analysing these skills will lead to improved designing of information architecture for elderly adults.

Specific Objectives of the study:

- The rate of frequency of elderly web users are low and has to be increased.
- To determine the type of information architecture that is beneficial for elderly.

1.5 Assumptions

- Respondents are expected to respond without bias and negligence.
- Cognitive abilities are the only contributing factors for information retrieval from web interfaces.
- At the time of performance of the interview tasks; website connectivity and disruption do not have any influence on the time taken to retrieve information from the websites.

1.6 Significance of the Study

Elderly people experience ageing differently. Hence they are considered to be a heterogeneous group. It is important to understand the informational needs and strategies used by elderly people in information retrieval from web interfaces (Dinet and Vivian).

The research is significant because it could be of enormous value to the elderly population if the information from the web interface is readily accessible. The current elderly population are intimidated by the use of web interfaces; this impression should be changed to facilitate the elderly demographic.

1.7 Layout of the Report

Chapter 2: Theoretical Framework

This section will discuss the various cognitive abilities specifically the theories around fluid and crystallised intelligence namely Cattell, Horn and Carroll theories.

Chapter 3: Towards Design Recommendations

This section will document the significant prior research in the field of information organisation and retrieval; gives a comprehensive account of the investigation method, which includes research method employed and data gathering process.

Chapter 4: Analysis of Qualitative Data

This section will present and analyse the data received in the form of semi-structured interviews, discuss the results in detail and the outcome of the proposed information organisation.

Chapter 5: Conclusion and Recommendations

This section will conclude by discussing the main findings and proposing design guidelines.

CHAPTER 2: THEORETICAL FRAMEWORK

The theoretical framework discusses the academic viewpoints of various scholars regarding the definition of the term elderly people and the effects of ageing on different abilities. The theoretical framework further discusses the factors that prevent older people from using technology and put forth an argument that cognitive ability is the first barrier when it comes to the use of technology. The definition of cognitive ability followed by the structure of cognitive intelligence as proposed by Cattell and Horn named Cattell-Horn theory of fluid and crystallised Intelligence, and a discussion of Cattell-Horn-Carroll theory provides useful insights on definitions of various cognitive abilities and a clear understanding of the same.

2.1 Elderly People

Active ageing as defined by World Health Organisation (WHO); “is the process of optimising opportunities for health, participation and security in order to enhance quality of life as people age” (Edwards 12). The word active does not just mean the ability to be physically active; it refers to continued participation in cultural, spiritual, social, economic and civic affairs. Active ageing aims to improve the quality

of life and extend life expectancy as people age (Edwards 12).

Ageing leads to physical and cognitive decline. Hamilton in his book *The Psychology of Ageing*, classifies old age as young-old (60-75), middle-old (75-84) and old-old (85+). This period of ageing (60+) is also called the third age were in the person lives an active and independent lifestyle and it moves on to the fourth age were in the person is dependent on others (Hamilton 17-18).

The chronological age is an arbitrary measure, and there is no single point of time at which a person automatically becomes old (Hamilton 18). For the purpose of this thesis, the term elderly people refers to people above 60 years of age since most of the research papers from the extended length of literature survey indicate old age to be from 60.

The WHO report and the book *The Psychology of Ageing* help me understand the intellectual or psychological changes caused by ageing and the scope to define my interviewees. The interviewees will be the elderly people who will help the author understand how they retrieve information when using a web interface.

2.2 Ageing and Abilities

"Several age-related changes in functional abilities have relevance to the design of computer systems. These include changes in sensory/perceptual process, motor abilities, response speed and cognitive process" (Czaja and Lee, "Information Technology and Older Adults" 24).

2.2.1 Sensory Decline

The sensory system which includes the eyes, nose, ears, tongue and skin is the brain's means of contact with the surrounding environment. As people age the sensory system decline, this decline starts in early adulthood. Predominately, the

eyes and the ears (visual and auditory abilities) have direct relevance in the designing of computer systems (Czaja and Lee, “Information Technology and Older Adults” 24).

With increasing age elderly people suffer from changes in visual acuity, loss of sensitivity to contrast, reduced adaption to darkness, changes in colour sensitivity, glaring, decline in the ability to detect target against a background and visual search skills (Kline and Schieber 296-331). These impairments though not severe in all elderly people; may decline gradually making it difficult to perceive and comprehend visual information given that computer technology is primarily based on the visually presented text (Czaja and Lee, “Information Technology and Older Adults” 24). Elderly people may find it difficult to select small targets on computer screen especially when using a mouse as compared to using a light pen. They may also face problems while perceiving small icons, reading e-mail and locating information (Charness and Holley 239-241).

Elderly people experience a decline in auditory function which results in loss of sensitivity to high-frequency tones, difficulty in understanding speech especially if it is distorted, problems localising sounds, problems in binaural listening and increased sensitivity to loudness (Schieber et al. 134-160). These impairments are also relevant to the design of computer systems resulting in elderly people finding it difficult to comprehend synthetic speech which is characterised by distortions and sounds from multimedia systems. Alerting sounds or feedback sounds such as beeps or pings may also be problematic for elderly people to detect (Czaja and Lee, “Information Technology and Older Adults” 24).

2.2.2 Motor Decline

Ageing leads to a decline in motor skills and slower response time. The ability to maintain continuous movements, disruptions in coordination and loss of flexibility

are some of the impacts of ageing. The onset of diseases such as arthritis can change the way elderly people are physically able to interact with technology. These factors lead to difficulty in using input devices such as the mouse and the keyboard (Czaja and Lee, “Information Technology and Older Adults” 24). Elderly people find computer tasks using the mouse, such as moving, clicking, fine positioning, dragging and double-clicking challenging to perform in comparison to younger users, especially the task of double clicking (Smith et al.).

Charness and Holley suggested that for tracking tasks and target acquisition task’s, elderly people’s performance could be improved with the use of alternate input device such as the light pen (240). The target-pointing time using a mouse was longer for elderly people as compared to younger and middle-aged people, however, there was no significant difference in pointing time when a touch panel was used (Murata and Iwase 774).

2.2.3 Cognitive Decline

The brain decreases in volume about 0.5% to 1% per annum as people age. This reduction in size is caused by the shrinkage of neurones and lowering of the interconnections between neurones. The decline in intellectual skills and mental functioning are correlated with decreased brain volume, primarily the changes in the prefrontal cortex, which controls a broad range of cognitive processes (Hamilton 39-48).

Cognitive processes such as attention, working memory, comprehension, problem-solving and reasoning, inference formation and interpretation, encoding and retrieval from memory decline as a person ages. There is also a decrease in information processing speed, and the time taken to respond (Czaja and Lee, “Information Technology and Older Adults” 25; Charness and Boot 253-257).

Tasks involving retrieval of information from the internet and use of comput-

ers is a complex cognitive task and places high demands on cognitive skills such as memory, reasoning, attention, learning and problem-solving. Recent data also indicate that cognitive abilities are also related to technology adoption, and people with high fluid intelligence (reasoning and problem-solving in novel situations) are more likely to adopt technologies such as computer and the internet. The use of information technologies like the internet is challenging for elderly people given the decline in cognitive ability with age (Czaja and Lee, "Information Technology and Older Adults" 25; Czaja and Lee, "The Impact of Ageing on access to Technology" 341-348; Czaja et al. 333-352; Charness and Boot 253-257).

2.3 Barriers to Using Technology

There is a common belief that elderly people are unwilling to use technology. However, research indicates that older people are receptive to technology (Czaja and Lee, "The Impact of Ageing on access to Technology" 343). There has been an increase in the number of elderly people adopting technology. However, research shows that seniors face more difficulty than younger people in using it (Czaja et al. 333). A survey by American Association of Retired persons shows that people above 65 years of age showcase less confidence in their ability to use computer ("Staying Ahead of the Curve 2013: The AARP work and career study.").

Some of the factors for elderly people not adopting technology include age, cognitive ability, motor ability, sensory ability, costs, lack of skills, lack of interest, concern about security of information, socioeconomic status, level of education and lack of access to technology. Attitude towards computers play a significant role in determining their usage by the elderly; people with more positive attitudes are more likely to use computers. Though older people are eager to learn how to use technology, they are anxious that they might find difficulty in learning and that they might take more

time to get used to technology (Morrell et al. 176-180; Charness and Boot 255-257).

The common reason attributed to why elderly people report computer anxiety and computer efficacy (beliefs about ability to use computer) is the complexity associated with many technology products. The lack of understanding and research on the needs and abilities of the elderly people, which leads to reduced usability among the elderly. Involvement of elderly people while designing technology and providing training can go a long way in increasing the use of technology among older people and boosting their self-confidence (Czaja et al. 335).

In "Factors Predicting the Use of Technology" Czaja et al. discuss the effect of age, education, computer anxiety, computer self-efficacy (beliefs about ability to use computer) and cognitive abilities on the use of technology. It is reported that people with less education and less experience with technology made minimal use of computers and the world wide web. The findings also indicate that computer anxiety plays a significant role in technological adoption and that self-efficacy predicted computer anxiety. The results of this study indicate the relationship between cognitive abilities and use of system interfaces by elderly. Among the barriers that prevent elderly people from adopting technology is the decline in cognition or cognitive ability. The strongest predictors for the use of technology by seniors are crystallised intelligence and fluid intelligence which constitutes cognitive abilities (Charness and Boot; Czaja and Lee, "The Impact of Ageing on access to Technology"). The study by Czaja and Lee in "The Impact of Ageing on access to Technology" indicates the importance of designing system interfaces with minimum demands on cognitive abilities (345-348).

2.4 Cognitive Ability and Cognitive Process

Francis Galton in 1883 proposed the theory of cognitive abilities in his book *Inquiries into the human faculty and its development*. He introduced a series of mental

tests to determine mental strength and weakness. He suggested that cognitive ability was hereditary in nature (Carroll 31).

John B. Carroll in his book *Human Cognitive Abilities* defines cognitive task as "any task in which correct or appropriate processing of mental information is critical to successful performance. A cognitive ability is any ability that concerns some class of cognitive tasks, so defined" (10). To better understand the term cognitive ability Carroll provides an example for differentiating a cognitive task from a non-cognitive task. The lifting of a barbell or digging of a hole would not be classified as cognitive tasks though these tasks might make use of processing of mental information to a certain extent because the main reason behind the completion of this task is the involvement of physical strength and muscular power. The work of repeating a series of numbers can be classified as a cognitive task because it involves the storing of digits in order in the memory and retrieving the stored information from memory (Carroll 10). A successful completion of a cognitive task requires more than one cognitive ability.

Example: Is tall the opposite of short? Tick, "Yes" or "No"

In the above example which involves a cognitive task four cognitive abilities are required for its successful completion.

- reading and recognising the words
- understanding the meaning of the words
- evaluating oppositeness of the words
- making a check mark

Each ability is considered to have a value of either 0 or 1. The above cognitive task is completed successfully only when all the four skills are awarded 1 (Carroll 23).

Carroll defines cognitive process as “one in which mental contents are operated on to produce some response. These mental contents may be representations or encodings either of external stimuli or of images, knowledges, rules, and similar materials from short-term or long-term memory” (11). The response may be either unobservable or observable (11).

2.5 Theories around Cattell, Horn and Carroll

Spearman in *General Intelligence, Objectively Determined and Measured, 1904* proposed a single factor model and stated that intelligence or cognitive ability consisted of a single unitary factor (g) termed general intelligence. The (g) factor is responsible for overall performance of mental ability tests and influences cognitive ability.

Raymond Cattell studied under Charles Spearman and received his PhD from the University of London in 1929. He conceptualised the two-factor fluid and crystallised intelligence model.

The intelligence tests prevalent in early 1933 were focused on acquired knowledge. This led Cattle to develop intelligence test with an emphasis on culture-free tests because as is stated, “among different cultural groups a common ground of knowledge, on which operations of reasoning could be performed” (Cattell, “A Culture-free Intelligence Test 1” 165). The test was graphical in nature and included mazes, picture series, item classification, progressive matrices and mirror images. This test was evaluated against the traditional tests prevalent namely the Binet and the American Council of Education (ACE) Psychological Test (Postlethwaite 22).

The findings of this experiment showed that children and immigrants exhibited high level of general intelligence (g) in the non-verbal section (which was culture-free) while the sample which consisted of teachers showed high level of (g) in the traditional

intelligence test (Postlethwaite 23). Cattell did not use the terms fluid intelligence (Gf) and crystallised intelligence (Gc) in his paper “A Culture-free Intelligence test 1” however, the contents of the article planted the seed for the theory of fluid and crystallised intelligence.

The Gf and Gc theory was published in the paper by Cattell “The Measurement of Adult Intelligence”. He argued that intelligence was not a unitary factor unlike Spearman had proposed (g), rather it consisted of two components which he later (1960) called fluid intelligence indexed as Gf and crystallised intelligence indexed as Gc (Catell, “Theory of Fluid and Crystallised Intelligence: A critical experiment” 2). Carroll acknowledges that the Cattell-Horn model “appears to offer the most well-founded and reasonable approach to an acceptable theory of the structure of cognitive abilities” (Carroll 62).

Gf which is the processing and the reasoning component of intelligence (Czaja and Lee, “The Impact of Aging and access to Technology”) increases throughout young adulthood and reaching maximum between ages 26 and 35 after which there is a steady decline (Kaufman, Johnson, and Liu; Wang and Kaufman). Gc increases with age throughout adulthood until approximately age 70 (Schaie), after which it may decrease slightly (Cattell, “Theory of Fuid and Crystallised intelligence: A critical experiment”; Horn and Cattell, “Age differences in Fluid and Crystallised Intelligence”).

The theory also states that fluid intelligence causes crystallised intelligence which implies, crystallised intelligence does not affect fluid intelligence. However, a greater fluid intelligence can change a person’s crystallised intelligence. The development of Gc depends on fluid intelligence to a large extent. “The level of Gf is considered to be unaffected by previous Gc acquisitions” (Schmidt and Crano 255).

Cattell’s doctoral student John Horn refined the theory of fluid and crystallised intelligence. He, along with Cattell, empirically tested Gf-Gc theory (Horn and Cattell, “Refinement and Test of the Theory of Fluid and Crystallised general Intelligences”).

Horn expanded the Gf-GC theory to include two factors namely General visualization (Gv) and processing speed (Gs), additional factors such as short-term memory (Gsm) or short-term apprehension and retrieval (SAR), long-term memory (Glm) or tertiary storage and retrieval (TSR), and auditory processing (Ga), and reading/writing ability (Grw) were added in due course. The other additions to the model include correct decision speed (CDS), quantitative ability (Gq) (Kaufman, Johnson and Liu 351; Carroll 61). Although the Gf-Gc model has been expanded to include other abilities, Horn still refers to the model as Gf-Gc theory. Fluid intelligence/ability and crystallised intelligence/ability represents the core of Gf-Gc theory. This theory is attributed to both Cattell and Horn and is hence, named as the Cattell-Horn theory of fluid and crystallised intelligence (Cole and Randall 161).

Carroll felt the need to thoroughly survey and critique the literature on cognitive ability (Carroll vii). He gathered data and factor-analysed 416 data sets. He then formulated the three stratum hierarchical theory (a three-tire model of intelligence) also called the Cattell-Horn-Carroll (CHC theory). Stratum 3 of Carroll's model is defined as general intelligence, similar to Spearman. Stratum 2 comprises of cognitive abilities stated by Cattell and Horn; Stratum 1 comprises of 69 narrow abilities also similar to Cattell and Horn (Postlethwaite).

The Cattell-Horn model and Cattell-Horn-Carroll model include same broad abilities (Stratum 2) and similar classification of narrow abilities (Stratum 3). There are four main structural differences between Carroll's model and C-H model (refer Figure 1), first, is that Carroll argues the existence of a general factor (g). C-H theory disagrees with the existence of a general intelligence factor (g). Carroll correlates cognitive ability to general intelligence (g), which is recognised as the highest order factor of cognitive abilities (Carroll 27; Cole and Randall 162). Second, Gq in C-H model (Stratum 2), which comprises of quantitative knowledge and quantitative reasoning is classified by Carroll as a narrow ability (Stratum 3) under Gf (Fluid intelligence). Third,

C-H theory includes Grw factor in Stratum 2, whereas Carroll includes reading and writing measure under Stratum 3 subsumed by Gc (Crystallised intelligence). Fourth, C-H and C-H-C model differ in certain narrow abilities (Flanagan and Dixon).

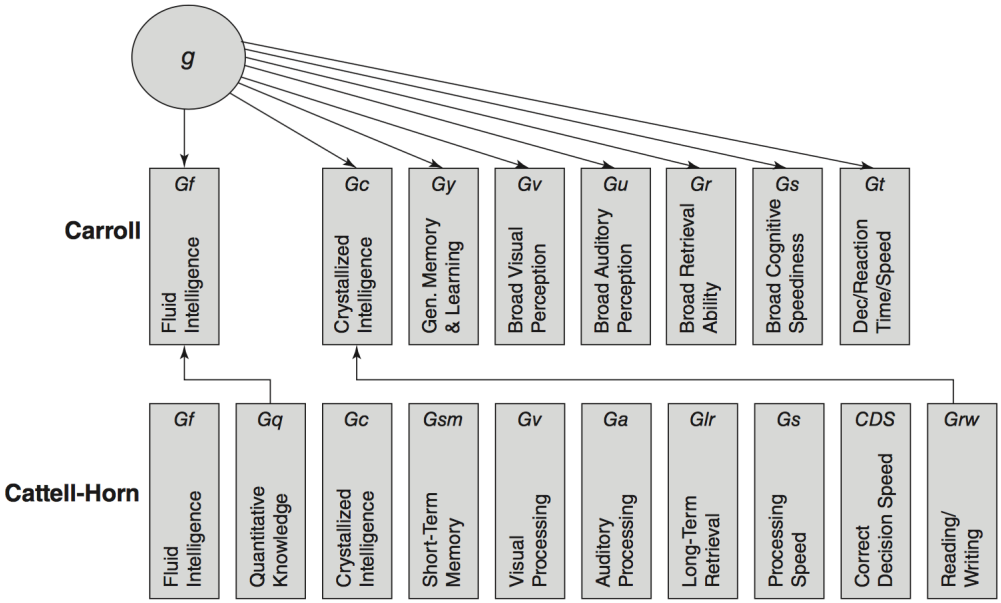


Figure 1: Comparison of Cattell-Horn Gf-Gc theory and Carroll's Three-Stratum theory, Source: Flanagan, D. P., and Kevin McGrew. "A cross-battery approach to assessing and interpreting cognitive abilities: Narrowing the gap between practice and cognitive science." *Contemporary intellectual assessment: Theories, tests, and issues*, edited by D. P. Flanagan et al., 3rd ed., New York Guilford Press, 1997, pp. 314-325. *ResearchGate*, `www.researchgate.net/publication/232448934_A_cross-battery_approach_to_assessing_and_interpreting_cognitive_abilities_Narrowing_the_gap_between_practice_and_cognitive_science`.

The history of the C-H theory provides useful insights on the level and kind of intelligence prevalent among different age groups. It is evident that children and immigrants have a low vocabulary and hence performed poorly in verbal section; while teachers who had high vocabulary displayed better performance in verbal section. It helped expand my knowledge on the various additions to the C-H theory which lead to its refinement.

While the C-H-C theory classified and defined the various cognitive skills; the C-H theory showed the age-related impact on fluid and crystallised intelligence. The diverse perceptive on the C-H theory by Carroll polished my understanding of the theory and the structure of cognitive ability.

As indicated by scholars the process of information retrieval from web interfaces makes use of different cognitive abilities like visualisation ability, verbal ability, perceptual speed, processing speed, working memory and spatial orientation in general (Czaja and Lee, "The Impact of Aging on access to Technology" 345). The C-H theory together with C-H-C theory gave a better understanding of fluid and crystallised intelligence in particular, and the interdependencies among the various cognitive abilities. The skills used in information retrieval tasks can be classified under fluid and crystallised intelligence (Pak and Price). The C-H theory is of importance because while there is a decline in most cognitive abilities as a person ages, the theory shows that crystallised intelligence increases. With emphasis on crystallised intelligence, elderly people can leverage their increase in crystallised intelligence to offset fluid intelligence, working memory and spatial location decline.

2.6 Definitions of Broad and Narrow Cognitive abilities

Fluid Intelligence (Gf): Cattell defines fluid intelligence as "a single, general, relation-perceiving ability connected with the total, associational, neurone development of the cortex" (Cattell, *Intelligence* 138). The term fluid implies that this type of intelligence "is not tied to any specific habits or sensory, motor, or memory area" (Cattell, *Intelligence* 138). Thus, fluid intelligence refers to problem-solving in novel situations, reasoning or abstract problem solving unbiased by education level or ex-

perience (Postlethwaite 3-8) (refer Figure 2 and Table 1). Fluid intelligence includes the following mental operations “forming and recognising concepts, perceiving relationships among patterns, drawing inferences, comprehending implications, problem-solving, extrapolating, and recognising or transforming information” (Flanagan and Dixon).

Narrow Stratum I Name (Code)	Definition
Fluid Intelligence (Gf)	
Induction (I)	Ability to discover the underlying characteristic (e.g., rule, concept, process, trend, class membership) that governs a problem or a set of materials.
General Sequential Reasoning (RG)	Ability to start with stated rules, premises, or conditions, and to engage in one or more steps to reach a solution to a novel problem.
Quantitative Reasoning (RQ)	Ability to inductively and deductively reason with concepts involving mathematical relations and properties.

Table 1: Narrow Gf ability definitions, Source: Flanagan, Dawn P., and Shauna G.Dixon. “Narrow Gf Stratum I Ability Definitions.” *Encylopedia of special education*, edited by Cecil R. Reynolds et al., John Wiley and Sons, 2013. *Wiley online Library*, dx.doi.org/10.1002/9781118660584.ese0431.

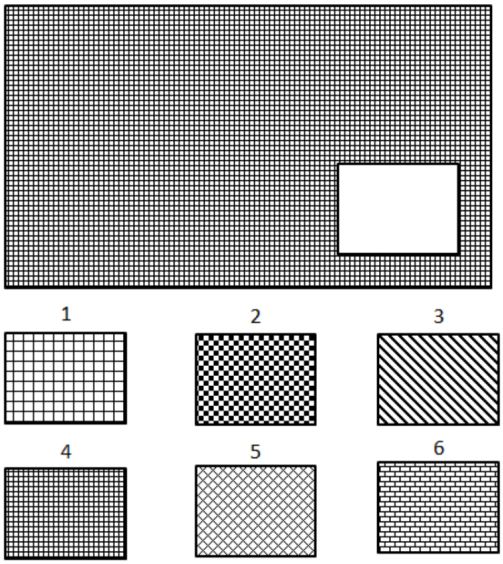


Figure 2: Example to assess Gf ability usage, Source: Postlethwaite, Bennett. "Example of a Simple Graphical Item Used to Assess Gf", *Fluid ability, crystallized ability, and performance across multiple domains: a meta-analysis*. PhD thesis, University of Iowa, 2011. `ir.uiowa.edu/cgi/viewcontent.cgi?article=2639&context=etd`.

Crystallised Intelligence (Gc): Cattell, 1987 defines Gc as "complex, acquired abilities, in the form of high-level judgmental skills in particular perceptual and motor areas" (139). The term crystallised implies "their expression is tied to a series of particular areas" (Cattell, *Intelligence* 139) or they are frozen "in a specific shape of what was once fluid ability" (Cattell, *Intelligence* 140). Crystallised intelligence refers to knowledge that is acquired over a period and is dependent on the level of education. Thus, crystallised intelligence includes verbal ability, language development, reading comprehension and general information (Postlethwaite 3-8) (refer Figure 3 and Table 2).

Gc includes static and dynamic knowledge also called declarative and procedural knowledge respectively. Static knowledge includes "factual information, comprehension, concepts, rules, and relationships, especially when the information is

verbal in nature. Declarative knowledge is held in long-term memory and is activated when related information is in working memory (Gsm). Procedural knowledge refers to the process of reasoning with previously learned procedures in order to transform knowledge. For example, a child's knowledge of his or her street address would reflect declarative knowledge, whereas a child's ability to find his or her way home from school would require procedural knowledge" (Flanagan and Dixon).

Gc is a store of both acquired knowledge (e.g., lexical knowledge, general information, information about culture) as well as processing abilities such as communication ability, listening ability, etc.(Flanagan and Dixon).

Narrow Stratum I Name (Code)	Definition
Crystallised Intelligence (Gc)	
General (verbal) Information (K0)	Range of general knowledge.
Language Development (LD)	General development, or the understanding of words, sentences, and paragraphs (not requiring reading), in spoken native language skills.
Lexical Knowledge (VL)	Extent of vocabulary that can be understood in terms of correct word meanings.
Listening Ability (LS)	Ability to listen and comprehend oral communications.
Communication Ability (CM)	Ability to speak in real-life situations (e.g., lecture, group participation) in an adult-like manner.
Grammatical Sensitivity (MY)	Knowledge or awareness of the grammatical features of the native language.
Oral Production and Fluency (OP)	More specific or narrow oral communication skills than reflected by Communication Ability (CM).

Table 2: Narrow Gc ability definitions, Source: Flanagan, Dawn P., and Shauna G.Dixon. "Narrow Gc Stratum I Ability Definitions." *Encylopedia of special education*, edited by Cecil R. Reynolds et al., John Wiley and Sons, 2013. *Wiley online Library*, dx.doi.org/10.1002/9781118660584.ese0431.

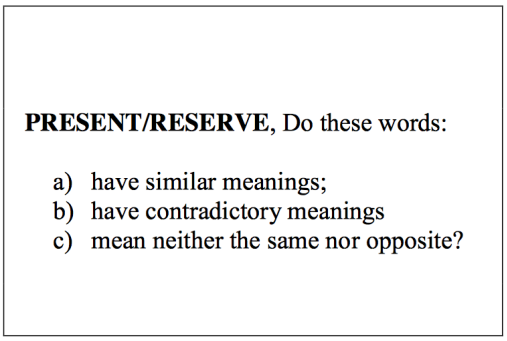


Figure 3: Example to assess Gc ability usage, Source: Postlethwaite, Bennett. "Example of a Question Assessing Gc", *Fluid ability, crystallized ability, and performance across multiple domains: a meta-analysis*. PhD thesis, University of Iowa, 2011. `ir.uiowa.edu/cgi/viewcontent.cgi?article=2639&context=etd`.

Quantitative Knowledge (Gq): Quantitative knowledge is knowledge related to mathematics it includes storing and acquiring mathematical knowledge and the ability to perform general mathematical calculations such as addition, subtraction, multiplication and division. There is a difference between quantitative knowledge and quantitative reasoning, while performing multiplication between two numbers can be classified as quantitative knowledge, finding a missing number in a number series task (e.g., 3, 6, 9, etc,) is a quantitative reasoning task. Carroll classified Gq under fluid intelligence (Flanagan and Dixon) (refer Table 3).

Narrow Stratum I Name (Code)	Definition
Quantitative Knowledge (Gq)	
Mathematical Knowledge (KM)	Range of general knowledge about mathematics.
Mathematical Achievement (A3)	Measured mathematics achievement.

Table 3: Narrow Gq ability definitions, Source: Flanagan, Dawn P., and Shauna G.Dixon. "Narrow Gq Stratum I Ability Definitions." *Encylopedia of special education*, edited by Cecil R. Reynolds et al., John Wiley and Sons, 2013. *Wiley online Library*, `dx.doi.org/10.1002/9781118660584.ese0431`.

Reading/Writing Ability (Grw): Reading/Writing ability is acquired knowledge that includes "basic reading, reading fluency, and writing skills required for the comprehension of written language and the expression of thought via writing. It includes both basic abilities (e.g., reading decoding and fluency, spelling) and complex abilities (e.g., comprehending written discourse, writing a story)." Carroll classified Grw under crystallised intelligence (Flanagan and Dixon) (refer Table 4).

Narrow Stratum I Name (Code)	Definition
Reading/Writing (Grw)	
Reading Decoding (RD)	Ability to recognize and decode words or pseudowords in reading.
Reading Comprehension (RC)	Ability to comprehend connected discourse during reading.
Reading Speed (RS)	Time required to silently read a passage or series of sentences as quickly as possible.
Spelling Ability (SG)	Ability to spell. (Not clearly defined by existing research.)
English Usage Knowledge (EU)	Knowledge of writing in the English language with respect to capitalization, punctuation, usage, and spelling.
Writing Ability (WA)	Ability to write with clarity of thought, organization, and good sentence structure. (Not clearly defined by existing research).
Writing Speed (WS)	The ability to copy or generate text quickly.

Table 4: Narrow Grw ability definitions, Source: Flanagan, Dawn P., and Shauna G.Dixon. "Narrow Grw Stratum I Ability Definitions." *Encylopedia of special education*, edited by Cecil R. Reynolds et al., John Wiley and Sons, 2013. *Wiley online Library*, dx.doi.org/10.1002/9781118660584.ese0431.

Short-term Memory (Gsm): "Short-term memory is the ability to apprehend and hold information in immediate awareness and then use it within a few seconds" (Flanagan and Dixon). Individuals can retain seven chunks of information since it

has a limited storage capacity (plus or minus two chunks). The ability to remember a telephone number is an example of Gsm; the information is retained for a few seconds and then it is lost when a new task requires an individual to use Gsm. The use of long-term memory can store this information by making use of cognitive learning strategy like continuously repeating the number (Flanagan and Dixon) (refer Table 5).

Narrow Stratum I Name (Code)	Definition
Short-Term Memory (Gsm)	
Memory Span (MS)	Ability to attend to and immediately recall temporally ordered elements in the correct order after a single presentation.
Working Memory (MW)	Ability to temporarily store and perform a set of cognitive operations on information that requires divided attention and the management of the limited capacity of short-term memory.

Table 5: Narrow Gsm ability definitions, Source: Flanagan, Dawn P., and Shauna G.Dixon. "Narrow Gsm Stratum I Ability Definitions." *Encylopedia of special education*, edited by Cecil R. Reynolds et al., John Wiley and Sons, 2013. *Wiley online Library*, dx.doi.org/10.1002/9781118660584.ese0431.

Long-term Memory (Glr): "Long-term storage and retrieval is the ability to store information in and fluently retrieve new or previously acquired information (e.g., concepts, ideas, items, names) from long-term memory" (Flanagan and Dixon). While Gc, Gq and Grw represent acquired knowledge stored in long-term memory, Glr is "efficiency by which information is initially stored in and later retrieved from long-term memory" (Flanagan and Dixon). Glr and Gsm are highly interdependent (Flanagan and Dixon) (refer Table 6).

Narrow Stratum I Name (Code)	Definition
Long-Term Storage and Retrieval (Glr)	
Associative Memory (MA)	Ability to recall one part of a previously learned but unrelated pair of items when the other part is presented (i.e., paired-associative learning).
Meaningful Memory (MM)	Ability to recall a set of items where there is a meaningful relation between items or the items comprise a meaningful story or connected discourse.
Free-Recall Memory (M6)	Ability to recall as many unrelated items as possible, in any order, after a large collection of items is presented.
Naming Facility (NA)	Ability to rapidly produce names for concepts when presented with a pictorial or verbal cue.
Associational Fluency (FA)	The ability to rapidly produce a series of original or useful ideas related to a particular concept.
Expressional Fluency (FE)	The ability to rapidly think of different ways of expressing an idea.
Sensitivity to Problems/Alternative Solution Fluency (SP)	The ability to rapidly think of a number of solutions to particular practical problem.
Originality/ Creativity (FO)	Ability to rapidly produce original, clever, and insightful responses (expressions, interpretations) to a given topic, situation, or task.
Ideational Fluency (FI)	Ability to rapidly produce a series of ideas, words, or phrases related to a specific condition or object. Quantity, not quality, is emphasized.
Word Fluency (FW)	Ability to rapidly produce words that have specific phonemic, structural, or orthographic characteristics (independent of word meanings).
Figural Fluency (FF)	Ability to rapidly draw or sketch several examples or elaborations when given a starting visual or descriptive stimulus.

Table 6: Narrow Glr ability definitions, Source: Flanagan, Dawn P., and Shauna G.Dixon. "Narrow Glr Stratum I Ability Definitions." *Encylopedia of special education*, edited by Cecil R. Reynolds et al., John Wiley and Sons, 2013. *Wiley online Library*, dx.doi.org/10.1002/9781118660584.ese0431.

Visual Processing (Gv): “Visual processing (Gv) is the ability to generate, perceive, analyze, synthesize, store, retrieve, manipulate, transform, and think with visual patterns and stimuli” (Flanagan and Dixon) (refer Table 7).

Narrow Stratum I Name (Code)	Definition
Visual Processing (Gv)	
Visualization (Vz)	The ability to perceive complex patterns and mentally simulate how they might look when transformed (e.g., rotated, changed in size, partially obscured).
Speeded Rotation (Spatial Relations; SR)	The ability to solve problems quickly by using mental rotation of simple images.
Closure Speed (CS)	Ability to quickly combine disconnected, vague, or partially obscured visual stimuli or patterns into a meaningful whole, without knowing in advance what the pattern is.
Flexibility of Closure (CF)	Ability to find, apprehend, and identify a visual figure or pattern embedded in a complex visual array, when knowing in advance what the pattern is.
Visual Memory (MV)	Ability to form and store a mental representation or image of a visual stimulus and then recognize or recall it later.
Spatial Scanning (SS)	Ability to accurately and quickly survey a spatial field or pattern and identify a path through the visual field or pattern.
Serial Perceptual Integration (PI)	Ability to apprehend and identify a pictorial or visual pattern when parts of the pattern are presented rapidly in serially or successive order.
Length Estimation (LE)	Ability to accurately estimate or compare visual lengths and distances without using measurement instruments.
Perceptual Illusions (IL)	Ability to resist being affected by perceptual illusions involving geometric figures.
Perceptual Alternations (PN)	Consistency in the rate of alternating between different visual perceptions.
Imagery (IM)	Ability to vividly mentally manipulate abstract spatial forms. (Not clearly defined by existing research.)

Table 7: Narrow Gv ability definitions, Source: Flanagan, Dawn P., and Shauna G.Dixon. “Narrow Gv Stratum I Ability Definitions.” *Encylopedia of special education*, edited by Cecil R. Reynolds et al., John Wiley and Sons, 2013. *Wiley online Library*, `dx.doi.org/10.1002/9781118660584.ese0431`.

Auditory processing (Ga): "Auditory processing is the ability to perceive, analyze, and synthesize patterns among auditory stimuli, and to discriminate subtle nuances in patterns of sound (e.g., complex musical structure) and speech when presented under distorted conditions" (Flanagan and Dixon) (refer Table 8). Ga is essential for the development of language skill (Gc).

Narrow Stratum I Name (Code)	Definition
Auditory Processing (Ga)	
Phonetic Coding (PC)	Ability to hear phonemes distinctly. This ability is also referred to as phonological processing, phonological awareness, and phonemic awareness.
Speech Sound Discrimination (US)	Ability to detect differences in speech sounds under conditions of little distraction or distortion.
Resistance to Auditory Stimulus Distortion (UR)	Ability to understand speech and language that has been distorted or masked in one or more ways.
Memory for Sound Patterns (UM)	Ability to retain on a short-term basis auditory events such as tones, tonal patterns, and voices.
Maintaining and Judging Rhythm (U8)	Ability to recognize and maintain a musical beat.
Absolute Pitch (UP)	Ability to perfectly identify the pitch of tones.
Musical Discrimination and Judgment (U1 U9)	Ability to discriminate and judge tonal patterns in music with respect to melodic, harmonic, and expressive aspects (phrasing, tempo, harmonic complexity, intensity variations)
Sound Localization (UL)	Ability to localize heard sounds in space.

Table 8: Narrow Ga ability definitions, Source: Flanagan, Dawn P., and Shauna G.Dixon. "Narrow Ga Stratum I Ability Definitions." *Encylopedia of special education*, edited by Cecil R. Reynolds et al., John Wiley and Sons, 2013. *Wiley online Library*, dx.doi.org/10.1002/9781118660584.ese0431.

Processing Speed (Gs): "Processing speed is the ability to perform sim-

ple, repetitive cognitive tasks quickly and fluently. These cognitive tasks often require maintained focused attention and concentration; therefore, attentive speediness encapsulates the essence of Gs" (Flanagan and Dixon) (refer Table 9).

Narrow Stratum I Name (Code)	Definition
Processing Speed (Gs)	
Perceptual Speed (P)	Ability to rapidly search for and compare known visual symbols or patterns presented side-by-side or separated in a visual field.
Rate-of-Test-Taking (R9)	Ability to rapidly perform tests which are relatively easy or that require very simple decisions.
Number Facility (N)	Ability to rapidly and accurately manipulate and deal with numbers, from elementary skills of counting and recognizing numbers to advanced skills of adding, subtracting, multiplying, and dividing numbers.
Reading Speed (Fluency) (RS)	Time required to silently read a passage or series of sentences as quickly as possible.
Writing Speed (Fluency) (WS)	The rate at which words or sentences can be generated or copied.

Table 9: Narrow Gs ability definitions, Source: Flanagan, Dawn P., and Shauna G.Dixon. "Narrow Gs Stratum I Ability Definitions." *Encylopedia of special education*, edited by Cecil R. Reynolds et al., John Wiley and Sons, 2013. *Wiley online Library*, `dx.doi.org/10.1002/9781118660584.ese0431`.

Decision Speed/Reaction Time (Gt): Reaction time is the individual's quickness/speed in making decisions. Gt and Gs are two different abilities while "Gt abilities reflect the immediacy with which an individual can react to stimuli or a task (typically measured in seconds or parts of seconds), whereas Gs abilities reflect the ability to work quickly over a longer period (typically measured in intervals of 2 to 3 minutes)" (Flanagan and Dixon) (refer Table 10).

Narrow Stratum I Name (Code)	Definition
Decision/Reaction Time or Speed (Gt)	
Simple Reaction Time (R1)	Reaction time to the presentation of a single visual or auditory stimulus.
Choice Reaction Time (R2)	Reaction time to one of two or more alternative stimuli, depending on which alternative is signaled.
Semantic Processing Speed (R4)	Reaction time when the decision requires some encoding and mental manipulation of stimulus content.
Mental Comparison Speed (R7)	Reaction time where the stimuli must be compared for a particular attribute.
Inspection Time (IT)	The speed at which differences in stimuli can be perceived.

Table 10: Narrow Gt ability definitions, Source: Flanagan, Dawn P., and Shauna G.Dixon. "Narrow Gt Stratum I Ability Definitions." *Encylopedia of special education*, edited by Cecil R. Reynolds et al., John Wiley and Sons, 2013. *Wiley online Library*, dx.doi.org/10.1002/9781118660584.ese0431.

The definitions for narrow cognitive abilities gives a clear picture of the characteristics of Gc and Gf and scope to understand better the terms that will help formulate design guidelines. There is also a close relation to different broad cognitive abilities like working memory, spatial cognition, processing speed, etc., to Gf and Gc as indicated in various parts of the literature. The different cognitive abilities discussed can be correlated to information retrieval on web interfaces. Where a greater emphasis on verbal skills will be beneficial for people with good vocabulary to retrieve information (Pak and Price).

CHAPTER 3: TOWARDS DESIGN RECOMMENDATIONS

This chapter gives an account of how cognitive abilities influence information retrieval on interfaces, and it discusses the relationship between information organisation and information retrieval. This chapter further examines the work done by Pak and Price in designing web interfaces keeping older adults is mind and the scope to propose an information organisation. The methodology adopted in this study along with a brief description of the NIH-Senior Health and the South African Tourism websites are explained in the last section.

3.1 Information Organisation and Retrieval

Age-related changes in cognition have implications for information processing tasks. During an interaction with technology Czaja and Lee state: “the user is required to search for and identify displayed information, select responses based on this information, recall commands and operating procedures associated with those responses and execute response” (“The Impact of Aging on Access to Technology”

344).

As pointed out by Vincente et al.; Czaja et al.; Sharit et al.; Pak et al.; Seagull and Walker; information retrieval tasks makes use of visualisation ability, verbal ability, perceptual speed, processing speed, working memory, reaction time, memory (long-term and short-term memory) and spatial orientation in general. Table 11 shows the various cognitive abilities that are involved in information search and retrieval tasks.

Authors	Computer Application	Cognitive Abilities
Vicente, Hayes, Williges	Information search and retrieval	Visualisation ability, verbal ability
Seagull, Walker	Information search and retrieval	Perceptual speed, visualization ability
Czaja, Sharit, Ownby, Roth, Nair	Information search and retrieval	Processing speed, memory, attention
Sharit et al.	Information search and retrieval	Psychomotor speed, working memory, verbal abilities attention
Pak, Rogers, Fisk	Information search and retrieval	Psychomotor speed, Perceptual speed, spatial orientation

Table 11: Importance of cognitive abilities for information search and retrieval

Yates and Nato in their book *Modern Information Retrieval* state that "information retrieval deals with the representation, storage, organisation of, and access to information items. The representation and organisation of the information items should provide the user with easy access to the information in which he is interested" indicating that basic information retrieval demands cognitive ability and engages information organisation (Yates and Nato 1). In extension and as shown by Onwechekwa, ease of information retrieval is therefore additionally dependent on efficient information organisation which makes it furthermore important to organise information efficiently to save time for the users who are seeking information (Onwuchekwa).

Effective information structure is most commonly dealt with in the field of in-

formation architecture. Therefore it is important that in addition to addressing the cognitive needs of information retrieval that the author also briefly addresses the subject from an information architecture perspective. Information organisation/architecture as defined by Rosenfeld and Morville is “the combination of organisation, labelling and navigation schemes within an information system” (4). In this structuring is the process of finding the appropriate level of the information and relating them to one another. Organisation involves grouping information into meaningful and distinctive categories. Labelling is the process of assigning names to categories (5). The relationship among cognitive abilities, information retrieval and information organisation clearly establish the need for designing an interface for older adults.

Elderly people’s performance in information search and retrieval tasks is lower than younger people due to their decline in cognitive abilities (Pak and Price 614). Pak and Price conducted a study to examine web-based information retrieval as a function of age for two information architectures namely, the hierarchical architecture and the tag-based architecture. The study carried out by Pak and Price examined how an information organisation focused towards elderly people can improve their performance in information search and retrieval tasks based on the Cattell, Horn and Carroll theories (Pak and Price 614).

3.2 Study of Information Organisation by Pak and Price

Pak and Price in “Designing an Information Search Interface for Younger and Older Adults” examine the possibility of an information search interface, that is redesigned to place more demand on crystallised abilities (verbal ability, qualitative ability) and reduce demands on fluid abilities (Working memory, Spatial ability, Visualisation ability, short-term memory, long-term memory) (615).

Pak states that in a hierarchical structure, a page on Orange might be located

hierarchically as shown in the example:

1. Fruits
    (a) Melons
    (b) Citrus
        i. Orange
        ii. Lemon
2. Vegetables

To get to the Orange page, the user has to select Fruits followed by Citrus. The user has to identify the top level folder to drill down to the required page. Each page has a unique location within a system, meaning there is a one-to-one relationship between the menu and the page that the user needs information from (615).

Hierarchical systems place a demand on spatial ability because the user needs to know where he/she is in the system (616). Research by Pak et.al, show that information search tasks that used hierarchically organised systems placed a demand on spatial ability. The performance in this kind of hierarchical structure is predicted by perceptual speed, working memory and spatial orientation.

Pak presents a tag-based system as a flat organisational structure with a many-to-one relationship placing emphasis on vocabulary and reducing demand on spatial ability (615).

From the previous example, the Orange page might be assigned tags such as Fruits, Citrus, Round, etc. The user can view the list of tags, clicking on any of the tags will take the user to the desired page (616).

It allows the use of multiple keywords/tags/labels, a piece of information or a page can be assigned any number of keywords, thereby increasing the probability of the page being found with the words being generated rationally by the user. The user

need not keep track of the higher level folder or categories and need not memorise words (617).

The goal of the study conducted by Pak and Price was to compare the performance of information search and retrieval task between younger and older adults in two information organisation interfaces namely tag-based and hierarchical. They wanted to examine if an age-related difference in information retrieval could be reduced by increasing vocabulary requirement and decreasing spatial ability demand. Pak also wanted to discuss if information retrieval in older adults can be improved by placing greater demand on vocabulary and reducing spatial ability need.

Pak and Price in their study gathered about ninety-six web pages from various sources on topics related to travel. The web pages were standardised and organised into taxonomy/hierarchical and tag-based structures as shown in Figure 4 and Figure 5.

The hierarchical organisation presented by Pak was obtained by performing card sorting, were undergrad students were asked to organise web pages into logical groups. This technique led to the creation of six main categories each with many sub-categories.

In the hierarchical structure, related web pages were placed into similar groups, which were in turn placed inside higher-order groups. In other words, each page is within an unambiguous category which is in turn within a general category.

In tag-based structure developed by Pak, the system was constructed by converting hierarchically organised web pages into pages arranged around tags. The tag-based system contained tags that were generated experimentally by converting the terms used in the hierarchical organisation.

The main difference between the two structures as stated by Pak is, in Figure 4, the page on Luggage can only be accessed by clicking Packing in case of a hierarchical system. However, in a tag-based system, the page on Luggage could be

reached by clicking Cruise Travel, Packing or Before you Leave (Figure 5).

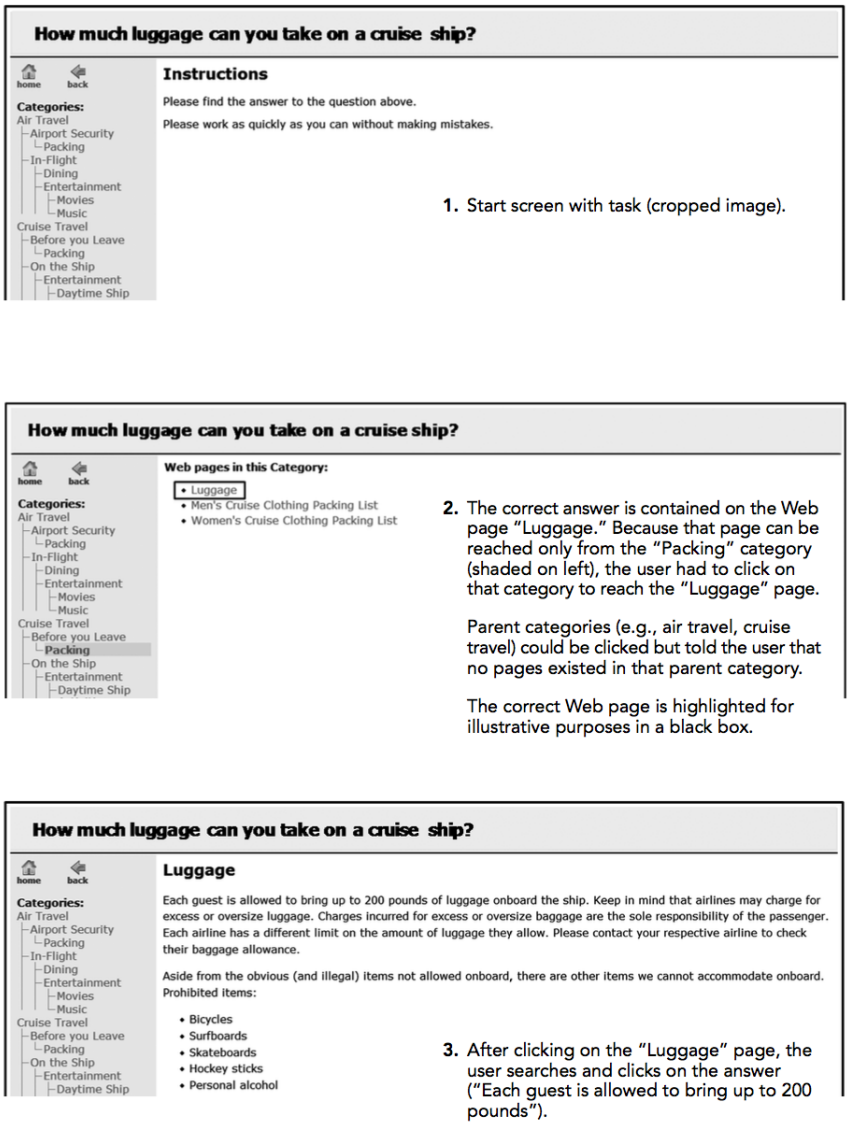


Figure 4: Hierarchical system designed by Pak and Price, Source: Pak, Richard and Margaux Price. "Taxonomic navigation condition." *The human factors and ergonomic society*, Vol. 50, No. 4, 2008, pp. 614-628. *SAGE*, doi.org/10.1518/001872008X312314.

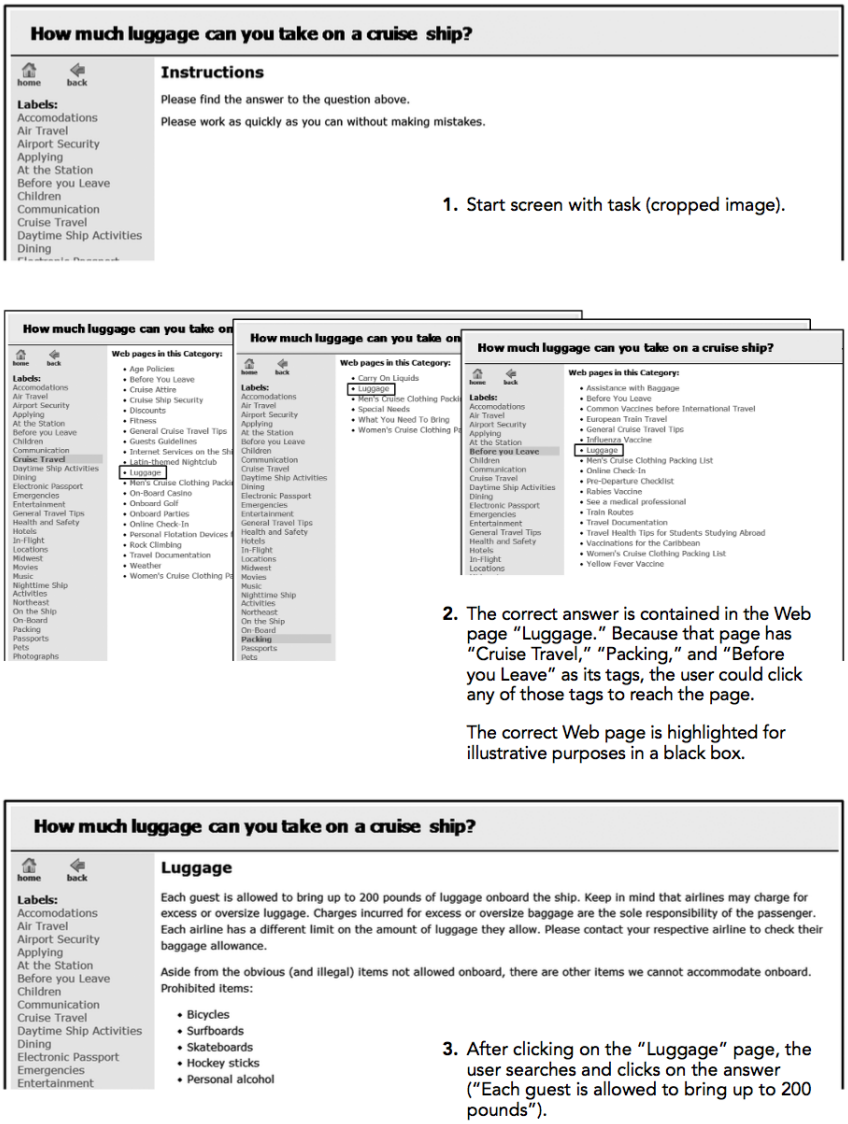


Figure 5: Tag-based system designed by Pak and Price, Source: Pak, Richard and Margaux Price. "Tag-based navigation condition." *The human factors and ergonomic society*, Vol. 50, No. 4, 2008, pp. 614-628. *SAGE*, doi.org/10.1518/001872008X312314.

The participants in the study which consisted of fifty younger people and fifty elderly people, conducted by Pak were asked to browse both the tag-based and hierarchical structures to retrieve information/answers related to specific questions posed in the form of tasks. The participants were given two practice tasks followed by 30

experimental tasks. For example, if the participants had to find information related to how much luggage they are allowed to take on a cruise ship, the participants will have to browse through either hierarchical structure or tag-based structure that contains information on luggage, the task ends when the user clicks on the correct answer (in this case 200), this will be followed by the next information retrieval task (Pak and Price 618).

The results from Pak's study shows that younger adults had higher spatial visualisation and orientation, perceptual speed, larger memory span than older people. The elderly people, however, scored better on vocabulary tests than younger adults. In hierarchy system younger adults showed better performance, however, in a tag-based system, there was no significant age-related difference in performance (Pak and Price 618).

To understand the reason behind elderly people's better performance in a tag-based system than taxonomy system Pak draws correlations between abilities and performance. Mainly, spatial ability and performance in taxonomy condition; vocabulary (crystallised ability) and performance in tag-based condition. Pak shows correlation with spatial ability in taxonomy condition, which suggest the performance in hierarchical systems are associated with higher spatial ability. The correlation with vocabulary in tag-based conditions suggests that the performance in tag-based systems are associated with higher vocabulary (Pak and Price 618).

Pak carried out hierarchical regression to determine the variable that uniquely predicted performance in hierarchical system and tag based system. He hypothesised "that performance in taxonomy condition would be predicted by spatial abilities not vocabulary, whereas performance in tag-based condition would be predicted by vocabulary, not spatial abilities, after we controlled for the influence of other variables" (625). Through regression, though he was able to prove that performance in a tag-based system was primarily predicted by vocabulary, he was unable to demonstrate

that performance in a hierarchical system was uniquely predicted by spatial ability and not vocabulary. As stated by Pak the inability to prove that spatial ability did predict performance in hierarchical condition was due to the design of the taxonomy condition, where the menu items were fully expanded (625).

Pak and Price conclude by stating that elderly people's performance in information retrieval tasks can be enhanced by organising information in a tag-based system which places more demand on vocabulary, thereby leveraging their increased crystallised abilities to offset fluid ability decline.

3.3 Towards a New Investigation

In response to Pak, and in contribution to this research report, I wish to test if an information architecture/organisation which uses an alphabetically arranged combination of both tag-based and hierarchical system can be beneficial for elderly people; by placing a demand on crystallised abilities which include verbal ability.

To explain the proposed system, consider tags Apple, Fig and Fruit. These tags can be arranged hierarchically in an alphabetical order of their first letter, using alphabetic indexing/menu structure. A person who wishes to read about Apple can choose the letter A which would, in turn, display the list of tags which start with the letter A; the person can then click the tag Apple to read about it. Clicking the letter F will display tags Fruit along with Fig, clicking Fruit will lead to a list of tags classified as fruits arranged alphabetically which will include Apple. Hence a user looking for information on Apple can read about it either by clicking the letter A or by clicking F both of which will hierarchically display the tag Apple. This system ensures a many-to-one relationship between tags; there are multiple access points to get to the same apple page. The user's verbal ability is used to a greater extent in this system. The user's search and all the tags in a website can be found in one stable place.

The alphabetically arranged combination of tag-based and hierarchical system will reduce demand on spatial ability, working memory, visualisation abilities, perceptual speed, reaction time which constitute fluid intelligence when retrieving information from web interfaces. My reasoning and rationale for proposing an alphabetically arranged combination of tag-based and hierarchical system are as follows.

Currently, elderly people do not belong to the technological world. But the future elderly would have used technology to a certain extent. A system needs to be developed which is beneficial not only for the current older people but also for the future elderly.

Golder and Huberman, state that a hierarchical structure is exclusive, meaning a web page related to a particular information will be found under one category or group. It, therefore, becomes necessary to check multiple categories/groups to obtain information that the user is seeking. Pak also points out the one-to-one relationship in hierarchical structures. In spite of the disadvantage that exclusivity of hierarchical system offers, an efficiently organised hierarchy system will ensure that the user's search is contained in a folder in one stable place (Golder and Huberman). The exclusivity of hierarchical structure can be turned into an advantage by using an alphabetically arranged combination of tag-based and hierarchical structure. The possibility of a many-to-one relationship is established due to the presence of tags, and also the hierarchical structure ensures that the users' search is contained in one stable place because the tags/keywords are arranged alphabetically and are linked to the related pages.

Although Pak was able to correlate spatial ability to taxonomy system, he was unable to prove that performance in hierarchical system was uniquely predicted by spatial ability and not vocabulary because the menu items were expanded/open, ("regression did not show that spatial abilities uniquely predicted performance in taxonomy condition" (625)). His primary concern was that in a hierarchical system the

user had to keep track of higher level folders which is a working memory and spatial ability demanding task. The alphabetically organised combination of tag-based and hierarchical system is an open or expanded menu structure which will not require spatial ability. The tags are arranged hierarchically in alphabetical order. In an alphabetically organised combination of tag-based and hierarchical structure, the user needs not keep track of higher level folders; hence eliminating the possibility of the impact of spatial ability on information retrieval.

The tag-based system developed by Pak contained tags that were generated experimentally by converting the terms used in the hierarchical organisation. Hence, the tags were not user generated. The tag-based system created by Pak did not allow the user to search and retrieve information based on keywords/tags using a search option. Instead, Pak provided an extensive list of tags/labels which will not be beneficial in a complex information retrieval task. As the data grows, it becomes difficult to manage information with tags alone. As the information increases the tags required to represent the information will also increase which will make it difficult to find the information that a person is looking for if the tags were to be presented as a list as presented by Pak. Hence, an alphabetically arranged combination of tag-based and hierarchical system will be beneficial to organise information. Retrieval of information will also be easy since they are present in one place.

The other important issue pointed by Golder and Huberman in tagging systems is what they call the “basic level” problem, where different people might use different terms at varying levels of specificity to describe an item. Golder and Huberman provide an example, for instance, while some may tag a page as Perl and Javascript which are specific keywords, others could tag the page as Programming at a basic level. The issue of basic level, i.e., a label that is considered basic by some may not be basic for others. The standard of specificity required to find a piece of information can be reduced with the use of an alphabetically arranged combina-

tion of a tag-based and hierarchical system. The user can either check for pages related to Perl and Javascript specifically under letters P; J, or the user can use the tag Programming under P, which will in-turn lead to a page with Perl and Javascript tags.

In Figure 4 and 5 which shows the hierarchical system and tag-based system, the question posed to the user is How much luggage you can take on a cruise ship? the hierarchical system shows both Air Travel and Cruise Travel under each of which is present Packing, under which is present the Luggage option. While clicking Packing under Air Travel will fetch luggage to be taken during air travel, clicking Packing under Cruise Travel will fetch information on luggage to be carried during cruise travel. In the case of tag-based system (Figure 5) to find luggage Pak has indicated that clicking either tag Packing or Luggage will display the required information. He has presented the information on Luggage for Cruise Travel but not considered Luggage in case of Air Travel. This confusion and discrepancies can be avoided with the use of an alphabetically arranged combination of tag-based and hierarchical system. The hierarchical aspect of the system will ensure that all pages are updated, linked and organised.

Czaja and Lee in “Impact of Aging on access to Technology” talk about the importance of minimising demands on working memory for elderly people which is the ability to recall (347). Hawthorn in his paper “Cognitive aging and human computer interface design” indicates the importance of providing suitable clues for retrieving information, which is the ability to recognise. Elderly people will find it effortless to retrieve information if they can identify keywords or alphabets rather than recalling complex navigational procedures. Emphasising on the ability to recognise letters and words can be achieved by the use of an open and alphabetically arranged menu structure as in the case of the proposed system.

3.4 Methodology

This study aims to look closely at an alphabetically arranged combination of tag-based and hierarchical system and test if such a system will be beneficial for the seniors. The proposed system emphasises on crystallised ability which includes verbal ability by reducing demand on fluid abilities.

This research will be qualitative. The theoretical framework which formed the basis for understanding the theory of fluid and crystallised intelligence in relation to information retrieval from web interfaces, helped the author understand the two information organisations namely hierarchical and tag-based. The proposed system which is an alphabetically arranged combination of tag-based and hierarchical will form the basis for conducting semi-structured interviews and tracking user interactions with elderly users.

Participants

The participants in the interview process will comprise of 12 active elderly people who will be interviewed separately based on a semi-structured questionnaire. The interviewees will be chosen based on their age bands (three each from the age groups (60-65, 65-70, 70-75, 75-80)) and their basic ability to use the computer and to browse websites.

Interviews

The National Institute of Health-Senior Health is a website that provides health-related information to elderly people such as symptoms, treatment of diseases, etc. It has been designed keeping the elderly users in mind. It makes use of the verbal skills of the elderly users hence placing emphasis on their crystallised intelligence.

The NIH website is a website that has an alphabetically arranged combination of tag-based and hierarchical system. The NIH website shows multiple ways to

access the same information using an alphabetically indexed, hierarchically organised tags. A user looking for information on Gout can click the letter G to find the information related to Gout. Clicking Bones and Joints under letter B will also lead the user to a page with the tag Gout.

The South African Tourism website is a recreational website providing information on the various places to visit in South Africa. The site has been designed for the general users. The website has a hierarchical organisation which lays emphasis on fluid intelligence.

A user looking for information on the best time to visit Karoo National Park could find this information only if they were to click Where to go in the menu, under which is displayed a list of provinces. Clicking Western Cape will show a list of places in the Western Cape which will lead the user to Karoo National Park. The page on the best time to visit Karoo National Park can be accessed only by following a certain navigational procedure. Hence this website is purely hierarchical.

The important informational needs of the elderly as pointed out by Dinet and Vivian (390) are health and recreation hence this research will consider the National Institutes of Health (NIH) senior health and South African Tourism (SAT) websites for the interview with elderly people. In the interviews, the elderly people will be asked to retrieve information from these websites in the form of tasks during the interview process.

Purely tag-based websites such as Flickr have not been considered for this study owing to the informational needs of elderly not being focused around photographs or videos. The Flickr website lacks in providing information to the elderly and may not be of interest to them. This website will not help in the process of information retrieval. The Flickr website is based on user-based tagging system, wherein the user can assign tags only to photographs owned or uploaded by them.

The interview questions will be based on how the interviewees retrieve infor-

mation from the website when asked for specific information. The interview will be audio recorded. Screen recording will be enabled when the participants are made to interact with the website. During the interview process; observations will be made concerning how the members retrieve information on the website and the path with which the participants navigate, and important notes will be recorded by the author.

The first stage of the interview will comprise of the following questions (refer Appendix A). This task will be audio recorded.

1. Do you use a computer and how frequently do you use?
2. Have you used the internet before; do you have access to the web?
3. How important is accessing the internet for you?
4. How frequently do you access the internet?
    - multiple times in a day
    - a couple of times in a day
    - once everyday
    - once every two days
    - once a week
    - once in few weeks
    - once a month
5. What is your purpose for using the internet?
    - Communication
    - Information
    - Education

- Entertainment
- Leisure
- Gaming

6. What information do you look for on the internet?
7. Do you use websites to find information?
8. What sites do you use frequently?
9. Do you think accessing information from these websites are easy or difficult?
    - If easy, why do you say it is easy?
    - If difficult, why do you think it's hard?
10. Which is your favourite website, among the sites that you use?
11. Why do you say this as your favourite website?

    In the second stage of the interview, the interviewee will be given some tasks to be completed. The tasks will be to find answers to the questions from the NIH and SAT websites. At this stage, the screen will be recorded to understand and compare the information retrieval tasks in both the websites in relation to cognitive abilities. The time taken to complete the given tasks will be documented.

    NIH-Senior Health

    - How long will a gout attack usually last after treatment?
    - What are the most effective means of dealing with symptoms of cataract?

    South African Tourism

    - What is the best time to visit Karoo National Park in Western Cape?

- The potholes, also called “Bourke’s Luck Potholes” in Mpumalanga, are formed by which river?

Once the interviewees complete their assigned tasks; they will be asked to provide inputs on the NIH and SAT websites respectively. The respondents will be asked the following questions which will be audio recorded following which the inputs from the respondents will be transcribed by the author.

12. What did you like and dislike about the two websites?
13. Which website according to you was easier to use and to obtain information from easily?
14. What made the other website difficult to use?
15. What improvements could be made to the site for you to obtain information quickly?

The time taken to complete the task, the ease at which the task is completed and the navigation path used to fetch the information will be some of the observations made by the author which will be documented. These observations will help the author evaluate and compare the health and the tourism websites respectively; to see if the proposed information organisation (an alphabetically arranged combination of tag-based and hierarchical system) does help the elderly people in retrieving information by making use of their increased crystallised intelligence.

The interviews with the respondents will be analysed using thematic content analysis to comprehend the usefulness of the proposed information organisation. Proposing design guidelines for the proposed information architecture on the basis of the analysis made and in consultation with Lisa Van Vliet, UX designer can help in better information retrieval when elderly people use websites.

3.5 An Illustration of NIH and SAT websites

3.5.1 NIH-Senior Health (NIH)

This website has been designed keeping the elderly users in mind. The health topics have been arranged alphabetically by the first letter. It is a combination of both tag-based and hierarchical systems. The website has minimal visual clutter to facilitate the elderly people. Relevant information is presented in consistent locations in a standardised format by following a natural grouping of information (refer Figure 6 and 7).

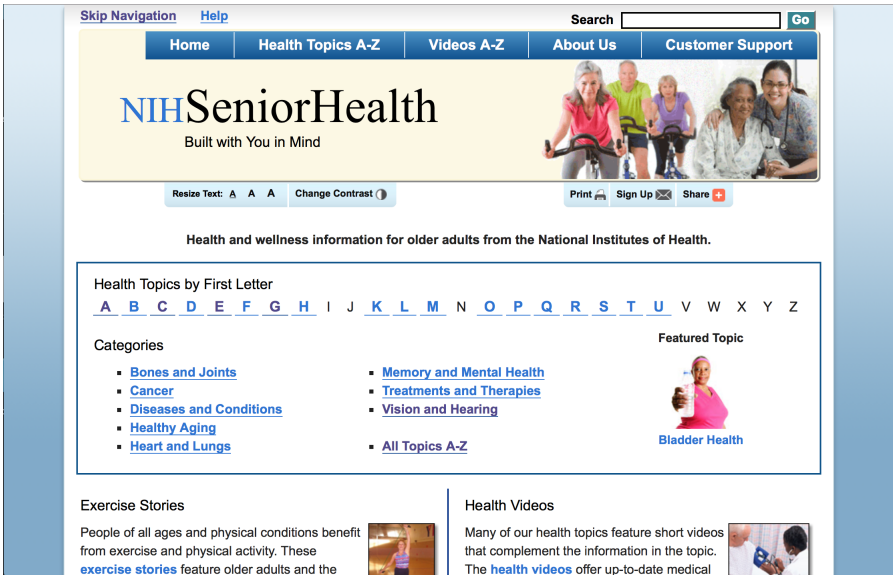


Figure 6: Screenshot showing the home page of NIH website, Source: *NIH Senior health*. National Institute of Health, Oct. 2003. `nihseniorhealth.gov`. Accessed 22 Feb. 2017.

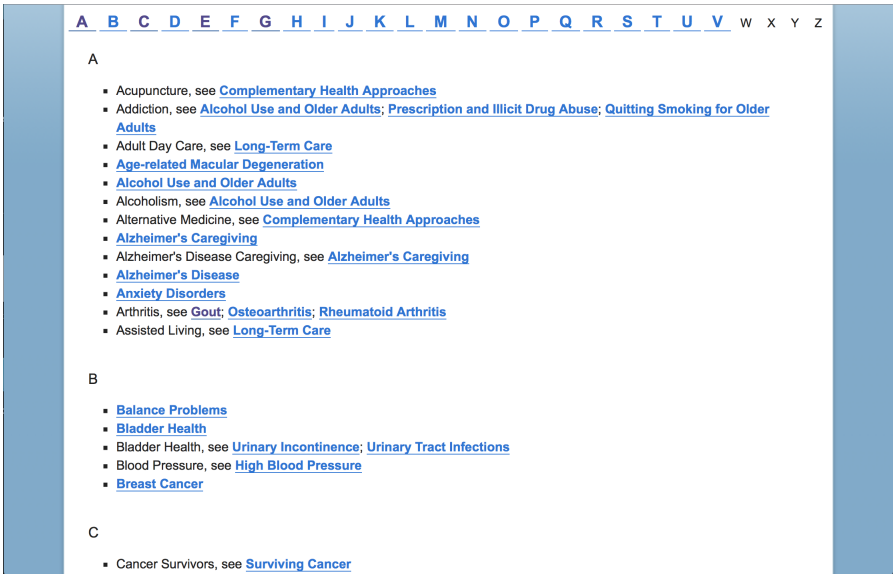


Figure 7: Screenshot showing the expanded menu structure of NIH website, Source: *NIH Senior health*. National Institute of Health, Oct. 2003. `nihseniorhealth.gov`. Accessed 22 Feb. 2017.

Pertinent information is categorised, with options being made visible, clear and easily locatable. The language used is simple. The links or tags are underlined and highlighted. The buttons are differentiated from the links/tags. The information is presented in short paragraphs with headings. There is also an option where the users can switch between varying font sizes and also change the colour contrast. Transcripts are provided for video information on health. An alphabetically arranged site map is also included for user convenience. The font style used is Sans-Serif (refer Figure 6). Czaja and Lee in “The impact of Aging on access to Technology” indicate the importance of using sans-Serif font style, as this style is beneficial for elderly users.

The menu structure is simple and consistent with no drop downs. The main menu consists of five buttons namely home, health A-Z, videos A-Z, about us and customer support. Clicking health topics A-Z will display all health related topics ar-

ranged alphabetically in an open or expanded format.

3.5.2 South African Tourism (SAT)

The South African Tourism website is designed purely based on a hierarchical structure. Though the website is consistent; it has a distracting background. The parallax effect makes the website difficult to use owing to the scrolling involved (refer Figure 8 and 9).

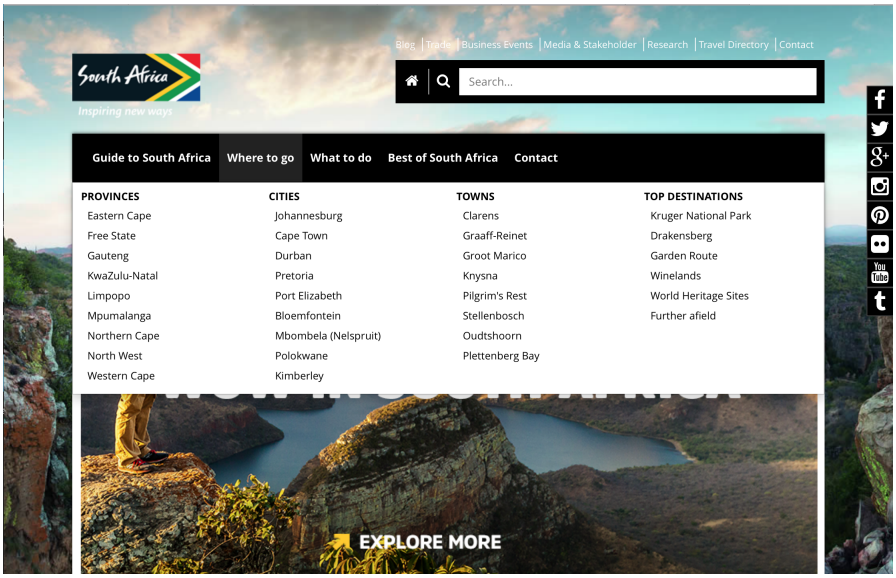


Figure 8: Screenshot showing the home page of SAT website, Source: *South African Tourism*. Minister of Tourism, 2009. `www.southafrica.net`. Accessed 27 Feb. 2017.

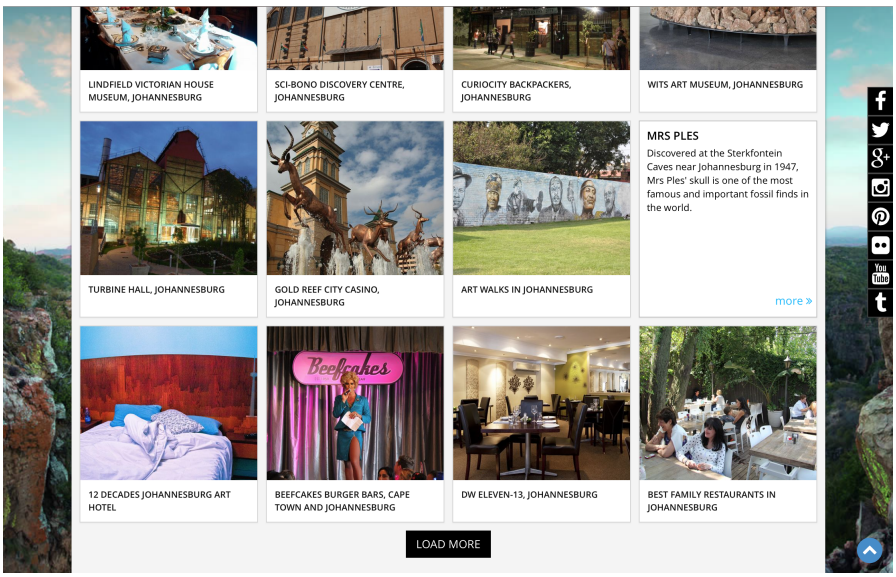


Figure 9: Screenshot showing the tiled arrangement of SAT website, source: *South African Tourism*. Minister of Tourism, 2009. `www.southafrica.net`. Accessed 27 Feb. 2017.

The information on places to visit is arranged in a tiled format, each tile has a picture and underneath the picture is displayed the name of the place. Hovering over the tile will display the information about the place in brief while clicking the tile will display the information related to the place in detail. The tiles are not alphabetical arranged and also if the user has to view more places to visit he/she has to use the Load More button and scroll further to see all the other places to visit. The menu structure consists of drop downs to view related information on places of interest. The font seems a little small as compared to the NIH website. The website does not provide a high contrast between the text and the background. The website has a prominent search bar which provides convenience to the user if the user is looking for particular tourism information.

CHAPTER 4: ANALYSIS OF QUALITATIVE DATA

This chapter discusses the planning and execution involved in the collection of qualitative data. The qualitative data is interpreted using thematic content analysis. The themes that emerged from transcribing the interviews were analysed in reference to the research questions.

4.1 Data Analysis Technique

The thematic content analysis involves collecting, analysing and interpreting raw data by interviewing and observing people (Vaismoradi et al. 400; Braun and Clarke 15-17). Thematic content analysis was found more suitable and reliable for analysis of qualitative data. This method also provides quality data which the researcher must identify, analyse and address based on the common themes that emerge from the raw data (Vaismoradi et al. 398-405; Braun and Clarke 15-17).

In conducting thematic analysis; the author followed a step by step procedure as suggested by Braun and Clarke. The first step involved familiarisation and immersion with the data set (Braun and Clarke 15-17). In the process of collecting the data, the author became familiar with the data set and tried to derive meaning from the raw

data obtained from the participants (Braun and Clarke 15-28). Immersion with the data set involved the author repeatedly going over the data set to get a deeper understanding of the data and exploring themes that were likely to be found in the data set. The author had to go over the data repeatedly which was a time-consuming process; which explains why qualitative researchers tend to use smaller samples than quantitative researchers (Braun and Clarke 18). This step was critical as it set the foundation for the analysis (Braun and Clarke 15-20). This step also involved transcribing the interviews into text so that a thematic analysis can be performed (Braun and Clarke 22). The second step involved the construction of codes from the data and grouping the data into similar groups (Braun and Clarke 20-25). This step was conducted manually. The third step involved analysing, sorting and categorising the coded data into similar themes. These themes were represented using Excel tables (refer Appendix D). The fourth step involved revisiting and checking the themes that had emerged from the data were related to the theoretical framework and research questions (Braun and Clarke 25-28).

4.2 Foundation to Data Gathering

In the first phase, the author went through the National Institute of Health-Senior Health (NIH) and South African Tourism (SAT) websites respectively to familiarise with the two web interfaces. The author selected tasks for the interviewees before the interview process. The author then conducted pilot interviews with two older adults to identify and eliminate any problems that would undermine formal interviews. One of the participants of the pilot interview; who was aged 64 used the computer frequently and browsed the internet for about couple of hours every day. The other pilot interviewee was 72 years old; used the computer moderately and browsed the internet for about couple of hours every two weeks. At the beginning of the interview

process, the participants were given a brief introduction on the purpose of the study and also on the tasks that they would be asked to perform. During the pilot study while one elderly participant aged 72 used the search bar provided on the two websites to look for information the other member aged 64 used the menu on the site. This disparity in the usage of web interfaces will make it difficult to gauge elements such as time taken and the navigation used to fetch information from web interfaces; which are the criteria used to assess whether the proposed information architecture (alphabetically arranged combination of tag-based and hierarchical structure) is suitable for elderly adults. To maintain uniformity among participants with diverse computer knowledge and to analyse the information organisation/architecture aspect of the web interfaces namely the NIH and SAT the participants in the formal interviews were not allowed to use the search bar.

In the second phase, a semi-structured interview with 12 elderly participants was conducted by the author (refer Appendix B). The interviews were carried out in the respective homes of the members and at a convenient time for the participants. Before the interview process, the members were handed a participant information sheet detailing the purpose of the study, and they were then asked to sign a consent form. The author divided the interview process into two stages; in stage one the interviewees were asked general questions about their ability to use a computer, the frequency of internet usage and their purpose for using the internet. In stage two the participants were asked to interact with the web interfaces to retrieve information using MacBook provided by the author. The MacBook used a portable Wifi device for internet access to facilitate browsing of the NIH and SAT websites respectively. Interactions with the web interfaces were screen recorded using Quicktime Software, with observations being documented by the author. The author also noted the time taken to complete the given tasks using a timer. The interviews with the participants were also audio recorded using the audio recorder on the phone and subsequently

transferred to the author's computer. The author later transcribed the audio recordings for thematic content analysis.

The participants were asked to perform two tasks each on NIH and SAT websites respectively. The first task on each of the web interfaces was a practice exercise and the second task which was then performed by the participants on each of the web interfaces were timed. The author created tasks such that; task one would help the users, mainly the non-frequent internet users to understand and get accustomed to the web interfaces. The author designed the task questions keeping in mind people with no prior knowledge of either the health conditions or the places of visit in South Africa.

To prevent errors in calculating the time taken to complete the timer based tasks, the method for calculating the time was standardised. The participants were asked to read the task/question; the author would confirm if the participant had read the question and if they were ready to navigate. The participant would begin navigating from the home page of the website when the author instructs the respondent to start; simultaneously the author would start the timer. The timer would be stopped once the participant highlights the answer to the question/task on the web page. The timer based exercise was performed exclusively for the purpose of comparing the time taken to retrieve information from the respective websites.

4.3 Outcome of Stage One Interview

The author selected three participants from each of the following age bands 60-65, 65-70, 70-75, 75-80. The interview engaged four male and eight female interviewees in the ratio of 1:2. Of the twelve members; eleven used a computer every day while the oldest participant being a novelist used the computer twice a week predominately for writing purpose. The oldest participant aged 79 used the internet once

a week usually to browse Facebook, while the other participants browsed the internet on an average of 2 hours per day.

The participants used the internet for various objectives namely news, health, recreation, music, spirituality, social media, entertainment, shopping, booking tickets and research (both academic and non-academic).

Some of the websites frequented by the participants include News24, BBC, Facebook, Woolworths. The members revealed that they used News24 and BBC websites mainly because the information on these websites was organised into international, national, health and sports news categorically. One of the interviewees stated that she used the Woolworths site because of its intuitive and graphically rich interface. Facebook was used by most participants for social interactions.

Most participants viewed the internet as an integral part of their life and a critical tool in today's world. Maximum participants recognised the importance of the internet in providing information. One of the participants considered the internet to be her friend; just like you can ask a friend anything, so is the case with the web. Another member mentioned that she would not be able to live without the internet.

Most participants used Google and Youtube to look for information. Most people trusted the information provided by Google, and they were of the impression that Google was the easiest way to obtain information. The participants used Google to type keywords of the concepts in mind and thereby seek information from the displayed list of websites. Most of the participants mentioned that they browsed sites directed by Google.

Participants indicated that they preferred websites that were informative, user-friendly, categorised, up to date, easy to use/navigate, current, sites that used simple language, and those that had visual information.

The brief summary of stage one interviews with participants gives an understanding of the informational needs of the participants, predilection for web interface

design and also their approach to navigating web interfaces. The participants conveyed their purpose for using the internet which included health and recreation, which corresponds to the findings made by Dinet and Vivian in “Elderly People as Web Seekers: Needs, Strategies and Difficulties” which also corroborates the selection of NIH and SAT websites respectively. The participants have also revealed the reason behind their inclination towards certain websites; which primarily constitute the organised and user-friendly aspects of the websites. These revelations further strengthen the importance of designing web interfaces with attention to information architecture for ease of information retrieval.

4.4 Observation of Tasks

The participants were asked to perform the following tasks on the NIH and the SAT websites respectively (see Table 12 and Table 13).

Tasks on the National Institute of Health - Senior Health website	
Task 1 - Practice task	How long will a gout attack usually last after treatment?
Task 2 - Timer task	What are the most effective means of dealing with symptoms of cataract?

Table 12: List of tasks on NIH website

Tasks on the South African Tourism website	
Task 1 - Practice task	What is the best time to visit Karoo National Park in Western Cape?
Task 2 - Timer task	The potholes also called Bourke’s Luck Potholes in Mpumalanga are formed by which river?

Table 13: List of tasks on SAT website

One common trend observed among the elderly participants was that; they feared not being skilled enough to perform the given tasks. They mentioned that they weren't sure if they would be able to do it, and were apprehensive of getting lost while navigating through the tasks. This made the respondents reluctant to participate, but they all allowed themselves to be convinced otherwise.

Even though the respondents intuitively knew what is to be done to complete the tasks, they needed constant confirmation from the author that they were on the right path. This action shows the insecurity among elderly people while encountering new situations; providing assistance will go a long way in helping older adults deal with new circumstances.

4.4.1 Task on NIH Website

For the first task on the NIH site; six participants fetched information on Gout by clicking G from the alphabetically indexed menu. Five participants used B for Bone and joints; which prompted the users to select the keyword Gout from a list of tags. One of the participants used K to be lead to a page which listed Knee as one of the tag words; clicking the keyword Knee, took the user to keyword Gout and in turn to the information on Gout.

Similarly in the second task; of the twelve respondents, eleven participants either clicked the letter C to get to information on Cataract or clicked V to be directed to Vision and hearing which in turn directed the users to information on Cataract. One of the respondents used E to be lead to a page with tag Eyes among others; clicking Eyes directed the user to keyword Cataract and later to the information on the ailment Cataract.

These observations of the navigational patterns indicate the importance of a many-to-one relationship between web pages and the role played by verbal abil-

ity/crystallised intelligence of the participants in trying to find information using various keywords at varying levels of specificity. The participants were able to use their vocabulary skills to generate words rationally and look for clues on the website to obtain information. The participants were able to recognise and interpret the keywords; this facilitated the users in getting the right information. The author observed that the participants showed no difficulty in obtaining the information that they were looking for from the NIH website because the website accentuated recognition over recall. The author noticed that the users were able to perform well both in the practice task as well as in the timer based task effectively and efficiently. These observations support the argument that NIH website placed more demand on crystallised intelligence which includes verbal ability.

The NIH website did not have evasive terms or tags to confuse the users. The Basic level problem was eliminated with the use of the tag-based system; it can be noticed that while some participants used keywords such as Eyes or Vision and hearing in general, some other participants used the tag Cataract to retrieve information. The language used on the NIH website was straightforward and relatable which was also a crucial feature of website design as indicated in the stage one interview with the participants, were the respondents stressed the importance of the use of simple language on sites.

The observations are in line with the argument that multiple access points will be beneficial for older users to navigate through web interfaces. The ever growing information on health-related topics can be conveniently arranged using tags in one stable place under the alphabetical index hence eliminating the chances of missing the information that elderly people are seeking. The author observed that users did not keep track of higher level folders because they were either conveniently using the button Health A-Z on the website to navigate or using the home button to reach the alphabetically arranged index on the home page of the website to obtain the list of tags

beginning with a certain alphabet. The author observed that none of the participants showed the need to keep track of the higher level folders since the structure was open or expanded and the website did not demand spatial ability. The open structure of alphabetically arranged health topics places less demand on spatial ability. The author observed that the number of steps taken by the users in reaching a specific information was less as compared to the SAT website where the participants found it hard to keep track of the higher level folders. The fluid ability demand is reduced to a greater extent when the older participants used the NIH website.

There were no drop down menus on the NIH website. The drop down menu system places demand on working memory and short-term memory; with the use of an alphabetically arranged combination of tag-based and hierarchical structure, the demand on these fluid abilities can be eliminated to a greater extent. The links were underlined to differentiate them from the headings and text which made it easy for the older adults to understand their purpose. The clutter was minimum. The headings were clear and distinct. The site indicated links visited previously with a different colour; this prevented the participants from repeatedly visiting the links as was observed in the case of SAT website, where the users lost track of their search and sometimes repeatedly visited certain pages in their pursuit for information.

4.4.2 Task on SAT Website

The SAT website is designed in such a way that the information can only be retrieved by following a hierarchical procedure. The information on Karoo National Park can be obtained by clicking the menu option Where to go followed by Western Cape. Similarly to access information on Bourke's Luck Potholes is by clicking Where to go followed by Mpumalanga. This navigation indicates a one-to-one relationship between web pages. There is only one access point to get to a particular information

on the web page. The hierarchical architecture was challenging for most participants.

Most respondents took quite some time to get accustomed to the web interface. To retrieve information on Karoo National Park, some of the respondents looked for information by clicking Best of South Africa followed by Top 10 regions which displayed irrelevant information. Similarly, hovering on the menu option Guide to South Africa; opened a drop down, clicking South Africa at a glance directed the user to general information about South Africa along with a list of keywords on the right hand side of the webpage; among which was a keyword termed Animals and Plants. Clicking this keyword lead the user to a brief description on various nature reserves in South Africa on the same page; with a brief mention about Kirstenbosch and Karoo which deluded some users.

The participants who clicked the sub-menu Destinations under Guide to South Africa were displayed a brief description about each province in South Africa in an irregular format. Ideally, the term Destinations should have directed the user to the various places to visit in South Africa based on the province. Similarly, one participant clicked Pilgrim's Rest from the list of places in Mpumalanga anticipating she would find information on Potholes because she knew Bourke's Luck Potholes was located closer to Pilgrim's rest, but she could not get to that information. Ideally, the web page should have catered to her information need. The author observed that the words generated rationally by the participants or the terms recognised on the interface did not direct the users to the right information deceiving the user. The language used on the SAT website was simple but not relatable to the search terms. It is observed that though the participants made use of their verbal ability/crystallised intelligence and ability to recognise words from menu items and the interfaces, the words used on the SAT interface were often misleading and not targeted towards the required information. The participants were compelled to use recalling capability which is associated with fluid intelligence. Crystallised ability correlates to recognis-

ing skills which could help the participating member to retrieve information in a much quicker time. An alphabetically arranged combination of tag-based and hierarchical system will ease information retrieval process by making use of the user's crystallised intelligence.

Some participants tried clicking the main headings on the web page assuming it would direct them to a list of places under that particular heading. Both the links and the headings were presented in the same style, and the participants were unable to differentiate between the two.

The author recognised that some of the participants repeatedly visited individual links even though the information that they were looking for was not present under those links because they had forgotten that they had previously visited them and also because the site did not differentiate the previously clicked links from the links that were never visited by them.

The author observed that the participants took a longer time to navigate the SAT website during the practice session as compared to the time taken to complete the practice task on the NIH internet site.

Three participants were able to comprehend the practice tasks and follow the second task on a similar channel as the first, the other participants took a longer navigational route and had to strive to reach their assigned task. The questions in the practice tasks and the timer based tasks were analogous. The participating members were not able to cope with the navigational path, and they found it demanding to get to the required information although they were given a practice task before the actual timer based tasks. The author observed that the purely hierarchical system posed a problem to the users as they had to use their spatial ability and always had to keep track of higher level folders for them to get the information that they were seeking.

The menu option was found to be challenging to use. The sub-menu faded away once the mouse was moved from the main menu option. The participants were

not satisfied with the sub-menu disappearing even before the participants could click the sub-menu items.

The information retrieval was indeed challenging, and the participants eventually clicked the menu item Where to go followed by the name of the province. This hierarchical arrangement can be of concern if the users do not know the geography of South Africa and that it is divided into regions. An alphabetically arranged combination of tag-based and hierarchical system will prove easy to use in this scenario considering the places can be alphabetically arranged into tags. The navigation becomes simple with the proposed system, and the users are not compelled to keep track of higher level folders.

Clicking the sub-menu item displayed the list of places in that province in a tiled format. Each tile was presented with a picture along with the name of the place at the bottom. Hovering over the tile displayed brief information about the place of interest. Three participants clicked the menu option Where to go followed by the name of the province more than once and it was evident that the name of the province displayed on the web page was small and camouflaged with the background picture and was not visible to the user.

Clicking the menu option Where to go followed by the sub-menu item Mpumalanga directed the users to places of interest in Mpumalanga in a tiled pattern. The general information on Mpumalanga was also presented in a tiled format which was causing inconvenience to the users looking for information on places to visit in Mpumalanga.

The graphical interface on SAT website was vibrant with pictorial representations of locations which mesmerised and distracted the users resulting in overlooking the information that they were searching. The participants spent considerable time scrolling to be certain that they have not missed any information.

The Load more option was available at the bottom of the page for the par-

ticipants to load more places. The participants had to click this option manually to load more places to be viewed. The option Load more was not clearly visible for the participants to be used. The correlation with parallax effect was difficult for the elderly people to use. Automatic loading of places could have been considered as the users scroll to the bottom of the page.

4.4.3 Time Analysis

The time analysis was performed to calculate the time difference in retrieving the information from NIH and SAT websites respectively, and it also provides information on the sample size of the participants. Table 14 and Figure 10 reviews the data, and it is evident that the time taken to retrieve information from NIH was much less than the SAT website.

Age	Time taken on NIH website (m:s:ms)	Time taken on SAT website (m:s:ms)
79	3:20:32	4:30:87
77	1:10:54	2:11:76
76	2:30:67	4:10:54
73	0:28:11	1:24:30
72	2:44:14	4:11:49
71	0:52:40	1:11:40
69	0:49:21	1:10:21
67	0:18:29	1:56:38
66	1:11:62	2:09:22
64	0:26:51	0:50:94
62	0:27:54	0:44:48
61	0:40:78	2:25:34

Table 14: Time taken to complete tasks on NIH and SAT websites

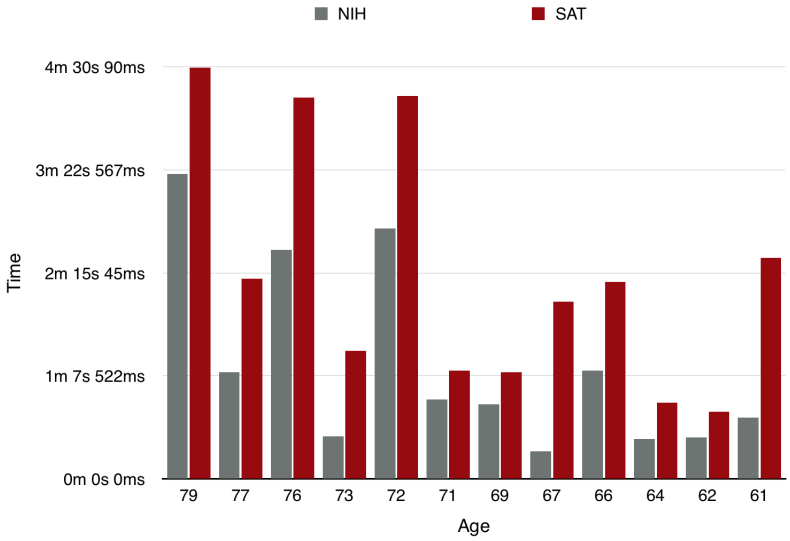


Figure 10: Graph of age vs. time taken to browse NIH and SAT websites

4.5 Outcome of Stage Two Interview

The entire sample size was able to complete the tasks on their own and was satisfied on completion of the tasks. Most participants were motivated to perform the next task on completion of the previous task. The participants seemed discouraged if the tasks took too long to complete or required lots of effort. The participants mentioned that they were contended with the instructions given to them by the author. The participants expressed that the tasks were unambiguous and straightforward to achieve. The participants with the least experience on browsing and using the computer were also appreciative and completed the prescribed tasks. Some participants were ignorant of the existence of such websites and were pleased to take some time and browse for more information. After the completion of the tasks, participants expressed that with experience browsing websites would become simple.

The participating members were asked to share their experience of using the

NIH and SAT websites; 11 out of 12 participants expressed that the NIH website was straightforward and simple to use than the SAT website. One of the participants who preferred the SAT website over NIH mentioned that he was impressed with the look and feel of the SAT website.

4.5.1 NIH Website

The navigation on the NIH website was such that it directed the users with no prior knowledge of ailments such as Cataract to look for information by clicking E followed by Eyes. This aspect was delightfully mentioned by one of the participants. This opinion expressed by the participant indicates the importance of multiple access points to obtain information from the website and eliminates the Basic level issue were people with diverse knowledge can use words at varying levels of specificity to look for information. The importance of an alphabetically arranged combination of tag-based and hierarchical system is evident in such scenario.

Ten participants revealed that they preferred the information architecture on the NIH website. The participants conveyed that the information on the NIH website was well categorised alphabetically, simple and straightforward. One of the participants, aged 72, suggested that an alphabetical organisation would be easier to use for the older generation compared to the younger generation. Some participants further mentioned that they did not have to read extensively on the NIH website as this was the case on the SAT website.

Most users specified the user-friendly nature of the NIH website. Two participants had extensive knowledge on health topics which indeed facilitated the participants browsing the NIH website to seek information. Few participants also mentioned that having images would enhance the appearance of the NIH Website which would in turn make the website attractive just like in the SAT website.

4.5.2 SAT Website

SAT website had excellent graphical representation with extensive information on the places to visit in South Africa. Though some participants indicated the visual appeal that SAT website featured; eleven participants expressed that the SAT website was challenging to use than the NIH internet site.

The information provided on the website was unclassified and intense that the user could not relate to the real charm of the places. Nine participants found this site informative, but they disliked having to read a lot of information before they get to the desired results. One participant aged 67 conveyed that the information presented was too much to read for her age.

The participants expected better categorisation and organisation on SAT website similar to the NIH website. Six members suggested that the SAT website to be alphabetically arranged to make information accessible. One participant aged 62 recommended the use of filtering options on the SAT website to improve usability.

A respondent aged 64 communicated that information retrieval on the SAT website would be demanding if the user did not know where to look for information. This concern was expressed by the author earlier; where a person with no prior knowledge about South Africa would find it challenging to navigate the SAT interface.

Three participants described that they found it laborious to keep track of their navigation. One respondent mentioned that she had to constantly move back and forth in her navigation and expressed that she found it had to remember the interaction.

The oldest member aged 79 suggested that the names of the places on the SAT website could be bold and distinct to improve readability. A user aged 61 referred to the Load more option on the SAT website and suggested that the SAT website load more places automatically without the user having to click the button each time.

4.6 Interview with UX Designer

The author conducted a semi-structured interview (refer Appendix C) with Lisa Van Vliet who is a senior UX designer at Barclays Africa Group Limited. The author wanted to gain insight into the design practices aimed towards elderly people in the corporate world. Van Vliet expressed; that it was unfortunate that people in the industry did not consider the age band above 60 while designing interface. She further added that their websites were targeted at young and middle-aged customers in the age group 25-45. The author then explained the demographic shift that would be observed in the coming years where there would be an increase in the elderly population and asked Van Vliet as to how they would deal with such a scenario. Van Vliet agreed with the author's concern and added that there would be a huge gap if the elderly demographic were not considered in the design process. To counter this argument, Van Vliet revealed that as designers; their principles were accessibility, empathy and ease of navigation all of which if catered to would enable any user group to obtain information.

Van Vliet was asked to perform the task on the NIH and SAT websites respectively. During the task, she expressed that knowing the geographical location of the places made a difference while using the websites. For instance, she was aware of the geographic location of potholes and had no difficulty in finding the information. This aspect was identified by the author during the interview process with the participants.

Van Vliet appreciated the author's research being focused towards elderly people and further added that the NIH website was a small step towards designing for seniors. She was of the view that the website could be further improved by personalising the website for every user based on their specific requirements. She

considered the SAT website to be more generic.

The observations made by the author and the opinions received from the participants were corroborating with one another and with the proposed system (alphabetically arranged combination of tag-based and hierarchical system). The thematic content analysis of the interviews and observations helps in concluding that the NIH website with an alphabetically arranged combination of tag-based and hierarchical system is benefiting the elderly users in retrieving information. The NIH website exploits the crystallised intelligence of the older adults and thereby reducing their utilisation of fluid intelligence.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

The internet improves the quality of life of the elderly by catering to their informational needs. However, usability concerns prevent older people from retrieving information efficiently from web interfaces. This research reviewed age-related changes on technology adoption and abilities that affect technology use. It further aimed at understanding the theories around fluid and crystallised intelligence; which formed the basis for proposing an alphabetically arranged combination of tag-based and hierarchical architecture.

This study helped to identify the implications of information organisation when elderly adults used web interfaces. An alphabetically arranged combination of tag-based and hierarchical structure uses more of crystallised intelligence over a purely hierarchical structure. Crystallised intelligence refers to knowledge that is acquired over a period and is dependent on the level of education. Thus, crystallised intelligence emphasises on verbal ability, lexical knowledge and grammatical sensitivity. Designing guidelines for web interfaces featuring crystallised intelligence will enhance the process of information retrieval by elderly adults.

The following design guidelines will enhance the process of information retrieval by making use of the crystallised intelligence of the elderly adults and reducing the fluid intelligence usage.

Recommendations Based on Information Organisation

- An alphabetical menu index should be present as it will enable users to look for keywords under specific alphabets.
- The tags can be placed hierarchically under their respective alphabetical index for better information retrieval.
- The many-to-one relationship between keywords and pages can be present to establish multiple access points.
- The users can use keywords/tags generated rationally at varying levels of specificity to find information thereby eliminating “basic level” problem.
- The open/expanded structure of the proposed system will reduce the demand on spatial ability. The user need not keep track of higher level folders.
- Participants can use their vocabulary skills to generate words rationally and look for clues on the interface thereby enhancing recognition over recall.
- The hierarchical arrangement of keywords in alphabetical order will ensure that the web pages are established in a stable place.
- People with no prior knowledge on the subject matter of the search will be able to retrieve information readily using an alphabetically arranged combination of tag-based and hierarchical system.
- An alphabetical menu index provides shorter navigational paths reducing demand on fluid intelligence. Therefore, the number of steps required to obtain information can be reduced.

Recommendations Based on Design

The following design recommendations can be considered while designing web interfaces for elderly.

- The use of simple language with identifiable words can help in information retrieval.
- Purely hierarchical drop down menu system may not be an ideal system for elderly people as it makes use of their fluid intelligence.
- Headings and links can be differentiated to provide distinctness.
- Colour coding previously visited links will prevent repeated browsing of web pages.
- The use of pictures will enhance the appearance of the web pages.
- Elderly people may find scrolling option challenging to use as a result of decline in motor ability. Therefore, designing web pages with minimum scrolling can be beneficial.
- The web pages should only display the essential text to avoid extensive reading.
- To improve readability text should not be camouflaged with the background.

Limitations

- A limited number of elderly participants were interviewed, therefore the findings from the study cannot be generalised.
- NIH Website and SAT Website were the only two websites used for the research purpose.

- The use of search engines such as Google or Yahoo may involve other usability issues which have not been taken into consideration.
- This research is limited to English speaking elderly participants.

Future Research

The findings of the study are based on the limited number of elderly members. Further studies can include more elderly participants or even younger generation to interpret the study in a much more detailed manner.

The research covered only two websites. Further research can be done with the inclusion of more websites with other usability issues.

The study dealt only with the find-ability aspect. Further research can be done with the inclusion of search-ability aspect where search-ability deals with the back-end code design for efficient use of search bars.

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Appendix A: Interview Questions

Interview Questions

STAGE 1

1. Do you use a computer and how frequent do you use?

2. Have you used the internet before; do you have access to the web?

3. How important is accessing the internet for you?

4. How frequent do you access the internet?
- Multiple times in a day
- A couple of times in a day
- Once everyday
- Once every two days
- Once a week
- Once in few weeks
- Once a month

5. What is your purpose for using the internet?
- Communication
- Information
- Education
- Entertainment
- Leisure
- Gaming

6. What information do you look for on the internet?

7. Do you use websites to look for information?

8. What websites do you use frequently?

9. Do you think accessing information from these websites are easy or difficult?
- If easy, why do you say it is easy?
- If difficult, why do you think it's hard?

10. Which is your favourite website, among the websites that you use?

11. Why do you say this as your favourite website?

STAGE 2

NIH

- How long will a gout attack usually last after treatment?
- What are the most effective means of dealing with symptoms of cataract?

SAT

- What is the best time to visit Karoo national park in Western Cape?
- The potholes also called “Bourke’s Luck Potholes” in Mpumalanga are formed by which river ?

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12. What did you like and dislike about the two websites?
13. Which website according to you was easier to use and to obtain information from easily?
14. What made the other website difficult to use?
15. What improvements could be made to the website for you to obtain information easily ?

Appendix B: Interview Transcripts of Participants

Respondent 1

Age: 79
Time taken to complete task 2 on NIH website: 3m 20s 32ms
Time taken to complete task 2 on SAT website: 4m 30s 87ms

Interviewer: **Do you use a computer?**

Respondent: Yes I do, its just a typewriter for me, I use it to write and a little bit of Facebook, that is if there is a notification or something's new on Facebook that is happening, I might read it, that's it

Interviewer: **Any other websites that you look at?**

Respondent: No, Not at the moment, Just Facebook, I tried to set up a Facebook for my theatre company, I was not very successful with that, so I gave it up as a bad joke.

Interviewer: **How many hours do you usually browse the internet?**

Respondent: I don't browse the internet

Interviewer: **As in facebook?**

Respondent: Once or twice a week, I spend more time just writing on it.

Interviewer: **When you look at Facebook, apart from notifications do you check anything else?**

Respondent: I don't open notification, I just check if there is any and then sometimes my friends and relatives might post a pic of birthday party or something like that, so I look at that and that's it.

Interviewer: **Do you post comments?**

Respondent: Just go write or like, that's it

Interviewer: **Any difficulties while using Facebook?**

Respondent: No difficulties, but I do have the temptation now and again to make political statements, you know when you read about things in the world that are not right and morally incorrect. So you wanna say something, but I think you know what, I will be inviting counter comments, I don't have the time to sit there and respond to all the feedback that I get after that. So I leave it.

Although people say that, you can learn a lot by just fiddling around with computers, than if you go for a course

Not keen on technology and all these things, being dismissive of it, I've just not learnt a lot about it, about things, I have never gone and said, ok I have this challenge, let me check on the net or see if there is a website about it, I'v never done that,

But you have just shown me now that, there is at least advice or answers to a lot of things, on the internet, let's say I did not want to believe it, I have to experience it or be told by somebody I could trust I am fine, I did not know that, these things are all there, Because I hear my daughter saying speak to uncle google you will get the answer.

First for a few months, who the hell is uncle google, then eventually I found out.

But I did try google, about a week ago, I was looking, because I love music, my grand daughter plays the violin and I play the guitar little bit. So I wanted to find out where I can get music lessons for keyboard, piano, I used google to find that around here. Grudgingly of course and here we are.

Interviewer: **Where you able to find that information?**

Respondent: Yes I did, I find quite a bit of it actually but it was not exactly close by here, until I went to the school where she went to and found out, and they said they will try and get me the information. Talking to their people in the same business.

Interviewer: **Were you successful in finding the information?**

Respondent: Yes, I was

From a medical point of view this is a great website, because we always go and I always hear people go to a hospital or go to a doctor or go to a clinic and come back and they have a million complaints, about the medical people did not understand their condition or that treatment is not working and all of that, I have got my aunt, she said to me, she went, they gave her a tablet, she came home and after taking it, feet started swelling, she stoped that tablet, she went to another doctor, he said no don't touch that tablet, so I said, where is the information as to why you should not touch that tablet, what did it do exactly, you know. What did he say, did he say that when you took that tablet it had this chain reaction or weather it, no he just said don't touch it, you know, so I stopped it, so she really does not know why they administered it in the first place and secondly she does not know why her feet started swelling thirdly the other doctor says no, don't touch that, and he didn't tell her why, so because I am pretty fit, it will be a few years I think before I have that kind of challenge, but now you have just shown me that, wait a minute I can go to a doctor and get diagnosed for something and still come back home and check all the things about this. Because obviously a lot of research has gone into this. Really good.

Interviewer: **Any place in South Africa that you want to visit?**

Respondent: I have been almost everywhere in South Africa, I want to do a Cape to Cairo road trip, that's what I want to do

Interviewer: **Any place in particular?**

Respondent: Swimming with the sharks in cape town

Interviewer: **Do you want to look for that information on this website?**

Respondent: Here, when you go on a tour, you want to go to places you don't know much about, so there would be that difference,

I am familiar with my own illness and want to find out more about that, I am unfamiliar with tourist attraction so it would be difficult for me to find, that's why I was struggling in this website.

Interviewer: **Considering the look of the website, did you like it?**

Respondent: they are very attractive, I would have definitely been attracted by the picture, and if I accidentally clicked on where to go and the music came up it would attract me, that was the other thing

Because, health issues people can be in denial as well, you know I am suffering from Gout and if I look there it's going to frighten me some more, you know, there will the two schools of thought, but I would try and health one would have more benefit than the tourism one, the tourist one is selling feature and it's an electronic salesman as opposed to the health which is some thing that is going to help you and the tourist you can choose to be a tourist or just stay at home, health you are stuck with it, let's find out more and try and get better.

Respondent 2

Age: 77
Time taken to complete task 2 on NIH website: 1m 10s 54ms
Time taken to complete task 2 on SAT website: 2m 11s 76ms

Interviewer: **Hello, Do you use a computer?**

Respondent: Yes I do

Interviewer: **How frequently do you use?**

Respondent: Everyday

Interviewer: **Do you use the internet?**

Respondent: Yes

Interviewer: **How frequently do you use the internet?**

Respondent: Work, I use quite often, maybe 4 hours a day

Interviewer: **For what purpose do you use the internet?**

Respondent: Mostly browsing

Interviewer: **What kind of information do you usually look for on the internet?**

Respondent: News mostly, music, religious things

Interviewer: **Any specific website that you like?**

Respondent: News24, BBC thats about it

Interviewer: **Anything that you like about these websites?**

Respondent: BBC very informative, News24 is informative but I don't really relay on the news that they give us because news24 basically is south African news

Interviewer: **Which website did you think was easier to use among the two was it the health or the tourism website?**

Respondent: Health

Interviewer: **Why do you think it was easier to use?**

Respondent: More familiar

Interviewer: **The tourism website, what issues did you face while browsing?**

Respondent: Searching it was a bit difficult. It was in proper categories but if it was alphabetically arranged, it would have been easier to find.

Interviewer: Any improvement you can suggest for both the health and the tourism websites?

Respondent: The health is ok if you know about it and it is easier to work about it, if people don't know about cataract then they are not going to find it there, so maybe cataract they need to say eyes specifically eyes, so cataract then the person can pick it up.

Interviewer: The tourism website, anything else you want to say about it?

Respondent: Seems to be very informative, obviously one needs to read more about it, read more into it, I am not too familiar with these websites, I hardly go to these websites. Will go into it to see what they are all about.

Respondent 3

Age: 76
Time taken to complete task 2 on NIH website: 2m 30s 67ms
Time taken to complete task 2 on SAT website: 4m 10s 54ms

Interviewer: **Do you use a computer?**

Respondent: Yes, I do

Interviewer: **How frequently do you use?**

Respondent: Almost everyday

Interviewer: **For what purpose do you use the computer?**

Respondent: I like to browse on cooking and then health issues a lot.

Interviewer: **Any particular website that you use?**

Respondent: I use youtube, I normally go to youtube, I link in the side were you get all those information and then I go in that, and then browse and see

Interviewer: **Why do you like youtube?**

Respondent: Because I feel, I can visually I can see that, that is the main reason why I go to youtube. Sometimes if I don't want to see visual thing, I will go to google and find information, because I feel google gives you the exact information so I go there, from there I go to youtube and then I see the visual there, that's how I do.

Interviewer: **What is the purpose for using the internet?**

Respondent: Cookery, health or any information, anything regarding household activity, whatever I just feel I just go, like with friends having a chat, I feel that with internet I can just be very friendly and I can go and use that's the main reason.

Interviewer: **Any favourite website?**

Respondent: Youtube, mostly I go to youtube, I don't have computer knowledge, I use google and youtube

Interviewer: **What did you find difficult in the health website?**

Interviewer: **What did you think about the health website, did you like it?**

Respondent: I did like it, it was easy for me to just browse, then I find it out, but I

Interviewer: **But it was not the same in case of tourism website is it?**

Respondent: ya, Tourism was a little bit difficult, I have to go again and gain, It was not that friendly as this, the health one was

Interviewer: Did you like the pictures of the tourism website?

Respondent: Ya, the pictures and the highlight what they gave, information that they gave, from that I could get to the information

Respondent 4

Age: 73
Time taken to complete task 2 on NIH website: 0m 28s 11ms
Time taken to complete task 2 on SAT website: 1m 24s 30ms

Interviewer: **Do you use a computer?**

Respondent: Yes, I do, not much now, but when I was working ya a lot, but now it's just for casual things

Interviewer: **Do you have access to internet?**

Respondent: Yes

Interviewer: **How many hours are you on the computer or internet?**

Respondent: Daily, I would say about two hours

Interviewer: **What is your purpose for using the internet?**

Respondent: It's for social media, looking at the news especially, news abroad, basically that

India ya

Interviewer: **Why do like it?**

Respondent: Simply because, of the current news in India, because we are, you know we still feel we are affiliated to India, you want to know what's happening there

Interviewer: **Any favourite website?**

Respondent: Its more the spiritual websites

Interviewer: **How do you like those websites?**

Respondent: They are very informative, very current, upto date, and you can relate to it because of the language

Interviewer: **Any issues that you face while using these websites, are you able to find the information that you are looking for?**

Respondent: It depends on which website it is, some of them are not updated and not current so you don't get the information that you need.

Interviewer: **Which website do you think was easier to use was it the health or the tourism website?**

Respondent: Both were equally user friendly, I think the health website was slightly easier in terms of the alphabetical index.

Interviewer: What issues did you have with the tourism website?

Respondent: I thought it should be more precise with the touristic places but I did struggle a bit, but otherwise it was ok, quite informative.

Respondent 5

Age: 72
Time taken to complete task 2 on NIH website: 2m 44s 14ms
Time taken to complete task 2 on SAT website: 4m 11s 49ms

Interviewer: **Do you use a computer?**

Respondent: Yes I do

Interviewer: **How often do you use?**

Respondent: Everyday

Interviewer: **How about internet?**

Respondent: Almost everyday as well

Interviewer: **How many hours do you generally use the internet?**

Respondent: Not for long, because my job does not entail much on the internet, but on a private basis I do

Interviewer: **What kind of information do you look for on the internet?**

Respondent: It depends on what I want to know, but I most of the time go on to the Satya Sai website, I use this website a lot, I like reading the information that comes.

Interviewer: **What do you like about that website?**

Respondent: Because it is spiritual, I like spirituality I am on that path, so I like to read on swami's teachings, the stories that he tells us, the miracles and the devotee stories and all the miracles they have experienced, their experience basically

Interviewer: **Any other information that you look for, other than spirituality?**

Respondent: It depends, if there is something that, sickness, I first prefer to try home based remedies and then if that does not work I will see the doctor, but most of the time I try and see that I can get home based remedy and that sort of thing

Interviewer: **Which website according to you was comparatively easy to use, was it the health or the tourism website?**

Respondent: I think the health, tourism wasn't too bad, its just that you know, you sometimes you look but you just don't see, you look properly and both sites were quite easy but I just did not look and read properly.

Interviewer: **Why do you think that was a problem, was it too cluttered is some way, were the letters too small?**

Respondent: I think it's just me not looking properly, because its quite clearly, you know, it's just a matter of reading. If you don't want to read it then you just won't see it, that sought of thing.

That part that you just click, Cataract as you had there, but here it is in blocks, that sort of thing. Or even same with, the tourism one

It was not difficult, if you are a computer literate then you should be able to pick it up easily. You just need to look and read.

Interviewer: **Anything else you would like to share regarding the two websites, anything that could be improved in the tourism or health website?**

Respondent: I think, on the health side more topics maybe, lot more different kinds of conditions.

To make it easier for people who do not know that disease to find in an alphabetical kind of order, that sough of thing.

Alphabetical order A,B,C if you are looking for cataract itself, you will see it under C section, instead of looking for cataract itself.

It would make it easier for the older generation I would say than for the younger generation I would say, so if they see it in alphabetic falls under specific letter of the alphabet.

The same I would say with the tourism as well. If you have looking certain specifics and if you have written that alphabetical kind of way, then you can find, look at it and see, A or D or E that sort of thing.

It is already here as well, I did see it there, but what came up was the other list, I did not see it there I could not fiddle with it actually.

I saw the vision and hearing

Interviewer: **Why did you not choose it?**

Respondent: I should have actually, I would have found it under the alphabets, I did not quite see it and think a lot, it is much easier that way, it is actually quite a nice website, because it gives you everything on all the different conditions alphabetically. My son suffers with Psoriatic arthritis so if we go under P we will find it

I did not even know there were these websites

I usually type the specific word on google and search of the information

Respondent 6

Age: 71
Time taken to complete task 2 on NIH website: 0m 52s 40ms
Time taken to complete task 2 on SAT website: 1m 11s 40ms

Interviewer: **Do you use a computer?**

Respondent: Yes

Interviewer: **How frequently do you use?**

Respondent: Everyday and all day

Interviewer: **How about Internet?**

Respondent: Yes

Interviewer: **How many hours do you usually browse?**

Respondent: It all depends, at work most probably about 3 hours, yes, it all depends how much information I would need from the internet.

Interviewer: **What purpose do you use the internet for?**

Respondent: I used to work for Dischem, so basically more to look into the medical aids, practitioners yes

Interviewer: **What about personal use?**

Respondent: Not much at work, but at home yes, but very little

Interviewer: **Favourite website you can think of?**

Respondent: Youtube

Interviewer: **Why do you like it?**

Respondent: Basically more for facials, weight loss and things like that, exercising

Interviewer: **Among the two websites, which are the health and the tourism, which one do you think is better and easier to use?**

Respondent: The health

Interviewer: **Why do you think it was easy?**

Respondent: I think because I work with health so I am quite used to the site

Interviewer: **And do you have anything else to share? Anything that could be made better in the health website, since you are from the health domain?**

Respondent: No, that was a good website and very easy to work

Interviewer: **What improvement would you suggest for tourism website?**

Respondent: It also seems quite user friendly as well, all the information is there, so, I don't really see much of a problem on the tourism website as well.

Respondent 7

Age: 69
Time taken to complete task 2 on NIH website: 0m 49s 21ms
Time taken to complete task 2 on SAT website: 1m 10s 21ms

Interviewer: **Do you use a computer?**

Respondent: Yes

Interviewer: **How frequently do you use?**

Respondent: Everyday, in a day maybe 6-8 hours

Interviewer: **Do you have access to the internet?**

Respondent: Yes I have access to the internet

Interviewer: **How important is accessing the internet for you?**

Respondent: I think nowadays it is very critical, I think internet it is information based, whatever you want, any information you will be able to retrieve from internet, weather it is education, academics or non-academic you will be able to find

Interviewer: **What is the purpose for using the internet?**

Respondent: I think for, technical side and internet I use it maybe in a day an hour, but mostly for the news and that kind of things.

Interviewer: **What kind of websites do you usually browse?**

Respondent: News24 and other sites, depends, but primarily news24

Interviewer: **What do you like about that website?**

Respondent: It is good, It is very user friendly, they have categorised nicely depending upon the various categories, it is one of the good site

Interviewer: **Can you think of any favourite website of your?**

Respondent: Google

Interviewer: **Why do you like google?**

Respondent: I think, For any, particularly if you have any technical challenges at work or something, I think that is much, one of the very easiest way to get the information, any information you will be able to get it from google.

Interviewer: **Which website do you think was better to use, was it the health or the tourism website?**

Respondent: The south African tourism

Interviewer: **Why do you think it was easier to use?**

Respondent: I think it is appealing, performance also looks good, I find it comfortable in terms of usability.

Interviewer: **Why did not like the NIH website? What could be made better?**

Respondent: I think the content wise both are same, I don't think there is any issue with the content, the health has its own, lot of informations are available with the health, but I think tourism you need very limited information, that is why they could make it simple. But in terms of look and feel, they have done much better, the tourism is much better.

Interviewer: **Why did you search, why did no use the menu in both the websites, is that the way you normally search?**

Respondent: I normally go for the search and then zoom into a particular portion and then you start looking into, just to reduce the time.

Interviewer: **When you were reading the questions that I asked, you were looking for words that I had mentioned in the question, was that what you were looking for?**

Respondent: Yes, from there, potholes, I was picking up the critical words, were I can exactly get into that place.

Respondent 8

Age: 67
Time taken to complete task 2 on NIH website: 0m 18s 29ms
Time taken to complete task 2 on SAT website: 1m 56s 38ms

Interviewer: **Do you use a computer?**

Respondent: Yes, I do

Interviewer: **How frequently do you use?**

Respondent: I use it everyday

Interviewer: **How about Internet?**

Respondent: I use it everyday

Interviewer: **For how many hours do you use the internet?**

Respondent: It varies, like maybe say I can't live without internet

Interviewer: **What kind of information do you look for on the internet?**

Respondent: I teach spiritual education, so I look for materials for teaching children and also to help with my grandson for his studies sometimes and hobbies

Interviewer: **Any websites that you look in particular?**

Respondent: Nothing in particular, I just go ahead with whatever content I am looking for

Interviewer: **Any favourite website?**

Respondent: Google

Interviewer: **What do you generally do on google?**

Respondent: Whatever I am searching for, I do have some permutation and combination until I get whatever I desired is available.

Interviewer: **Which website did you like among the two, was it the health website or the tourism website?**

Respondent: I liked the health website

Interviewer: **Why did you like the health website?**

Respondent: Because, whatever I was searching for was available in that index

Interviewer: **Why did not like the tourism website?**

Respondent: I would not say I did not like it, It is beautiful especially with the pictures and information but probably for my age I think if there was search option which was very effective it would have helped me a lot.

Respondent 9

Age: 66
Time taken to complete task 2 on NIH website: 1m 11s 62ms
Time taken to complete task 2 on SAT website: 2m 09s 22ms

Interviewer:	**Do you use a computer?**
Respondent:	Yes
Interviewer:	**How frequently do you use the computer?**
Respondent:	So at work I am on the Computer the whole day basically and at home it's not so much I mainly use my cell phone
Interviewer:	**Do you use the internet often?**
Respondent:	Yes, everyday
Interviewer:	**How important is accessing the internet for you?**
Respondent:	It is very important the main reason for me being you know my grandson always has a lot of questions to ask. So the internet comes in very handy in terms of trying to find information. So I think I am a curious person inquisitive person so I like to know what is happening in the news and all of that and I use that for the internet
Interviewer:	**What is your main purpose for using the internet?**
Respondent:	Accessing information, that is the main thing and shopping as well. Sometimes even it is not online shopping. I would like to research what I am about to buy. So I use it for research in that sense.
Interviewer:	**What is your favourite website?**
Respondent:	It's generally the news website. I can't identify specific one and say this is the one that I really like because it depends on what google direct me and depends on what I am searching for
Interviewer:	**So if you can think of a favourite website what would that be?**
Respondent:	I like the Woolworths website because I like shopping there. So I go there just to see what they have, what special they have before I

actually go there.That is my favourite one. Then I like News24. That's where I am at most of the time

Interviewer: **Why do you like these websites?**

Respondent: So the Woolworths one because I use it for my shopping decisions. It is very intuitive for me and also I like the graphics. It really helps me visualise what it is that I am going to be buy. I like that. News24 I like how its organised, it has local news, international news or sports news, its easy for me to navigate.

Interviewer: **Which website do you think was easier to use, which one did you like?**

Respondent: Both of them were easy to use. I like the first one because it has categories of what I am looking for like treatment, that was able to direct me whereas I had to go through a lot of text, to get to the answer, though I must say it "the Karoo" has sub headings and I can quickly scan through to get what I was looking for.

Interviewer: **What changes would you make to the tourism website?**

Respondent: I kept miss spelling the Potholes, I would like for it to have an idea of what I am looking for google sort of gives you ideas, are you looking for this, here it was telling me I can't find it. It should have a help function.

Interviewer: **What changes to Health website?**

Respondent: I think that the search function should be prominent, pictures would help, coz now it looks more like a textbook kind of thing, but it gave me the information I was looking for. Maybe its psychological, I didn't have the level of curiosity that I had in this one.

Respondent 10

Age: 64
Time taken to complete task 2 on NIH website: 0m 26s 51ms
Time taken to complete task 2 on SAT website: 0m 50s 94ms

Interviewer: **Do you use a computer?**

Respondent: Yes

Interviewer: **How frequently do you use?**

Respondent: All the time

Interviewer: **How frequently do you use the Internet?**

Respondent: Yes, nearly all the time

Interviewer: **How many hours do you use the internet?**

Respondent: Throughout my working day I have to use it, I need it for my work, for research

Interviewer: **What kind of websites do you usually browse?**

Respondent: It is a combination of client websites, where I read their annual statements, their products and services, it is a combination of my own internal websites to go look for information of our products and services, generally industry research then specific websites where only members are allowed access, professional websites for consulting technology and so on, it is a variety of sites

Interviewer: **Any specific website that you can think of, any favourite website?**

Respondent: I don’t have a favourite website, but most frequently used website, I will give you examples, www.transnet.net, my own company which is www.dimensiondata.com, www.tmforum.org

Interviewer: **When you were designing website for your company what are the things that you considered?**

Respondent: My role is not in design, my role about utilising information and going and consulting, for the most part I don't get involved in website design.

Interviewer: **Which website did you think was easier to use?**

Respondent: Easy to use was National Health, it was very structured, you go search and get the answer you want. In terms of the tourism website certainly for the Karoo and the Karoo national park, it is more easy to

use the search function then navigate through the website, the website has lots of information. It is hard to find unless you sit and search it's hard to pinpoint what you want. I had to load pages before I got to that. So either the Karoo National Park has not got such a high search engine rating to put it on the top, people are not hitting it enough which means they needs to find ways to raise that, from a website perspective there is far too much information their needs to better classification or categorisation. If you know where to look at least its fine, but I think otherwise it is a bit more difficult to use.

Interviewer: **What do you think about the NIH?**

Respondent: I think visually the tourism had better appeal, searching for information I think health was better because I think arranged according to topic and alphabetical order helped. Because you know you can go to a particular source of information.

Respondent 11

Age: 62
Time taken to complete task 2 on NIH website: 0m 27s 54ms
Time taken to complete task 2 on SAT website: 0m 44s 48ms

Interviewer: **Do you use a computer?**

Respondent: Yes I do

Interviewer: **How frequently do you use?**

Respondent: Probably three to four times a day

Interviewer: **How about the internet?**

Respondent: For the most part internet

Interviewer: **How many hours are you on the internet?**

Respondent: In a day maybe two to three hours, but split over a time but not continuously

Interviewer: **What is the purpose for using the internet?**

Respondent: Sometime to book things, entertainment stuff like that, personal and social, work related. I am not employed now so I don't use that it much. Earlier was for a lot of work. I used to look for new ides for work. Basically for lot of research work

Interviewer: **Any particular website you can think of which you really liked?**

Respondent: Normally, for work I look for ideas on menu food presentation so, ones where you had lot of picture representation so that you get ideas for presenting Indian food in a different way that was my line of work also for decor idea. I used keywords, it was not one website, try get ideas, see what we could do with what we have.

Interviewer: **Anything you liked or disliked about these websites?**

Respondent: I don't remember the name specifically because there was no one website that I was hooked on to, but the ones that gave you clarity in pictures, because I was looking for visual ideas, so the ones that describes an idea through pictures and also had little videos on how the particular shape or structure was achieved was little more intriguing and interesting for me rather than one that had chef talking about it or given in written script. So I found those ones easier to work with.

Interviewer: **Which website do you think was easier to use, was it the health or the tourism website?**

Respondent: The health definitely

Interviewer: **Why do you think the health was better?**

Respondent: It was more structured and it was, the information was designed keeping in mind the person searching finds the answer easily. In tourism, they way they did it, this is my thinking, you know they don't want you to decide where to go, I think when you go into western Cape they want you to show you all that the cape has to offer. So they don't want you to go and find answer to a particular site that you want to visit. I think that want you to surf, they want you to look at all those pictures and see what else you can do and look at a few more things but the health one their agenda is you got an ailment or someone you know has an ailment, you want to know what to do so you get to the point quickly. I think that was designed with that in mind. The tourism is like shopping, pick and pay they don't keep the bread and milk together, they want you to go through two three ails shop a bit more. I think that's the difference. This is totally different. But I would have spent more time on the tourism website, because I would have said, Oh! I did not know about this or that but the other one I would have gone only if I wanted a cure for an ailment or prevent something. Tourism website, instead of listing all the places they could have most visited in the last year, or example if I am searching in Feb, the ideal places to visit in March, so I would know it is seasonal and it is nice thing to go because I may not read through everything to know that, especially tourism I think that would be nice. Health everything was straight forward it can't get easier than A-Z. You click the alphabet the disease starts with then you have information from there.

Respondent 12

Age: 61
Time taken to complete task 2 on NIH website: 0m 40s 78ms
Time taken to complete task 2 on SAT website: 2m 25s 34ms

Interviewer: **Do you use a computer?**

Respondent: Yes

Interviewer: **How frequently do you use?**

Respondent: The entire day that I am at work

Interviewer: **How frequently do you use the internet?**

Respondent: Usually to look for something or check my emails, I use it off my phone

Interviewer: **What kind of information do you usually seek from the internet?**

Respondent: So in my line of work, sometimes you just need to look up certain things on the internet so, I go on quite occasionally to look for stuff on the internet, If you don't understand something or if you were to look for a particular name of a product and just for well social things as well use the internet a lot to look for restaurants, things to do to book tickets, so use it for a lot of social aspects as well

Interviewer: **Any favourite website?**

Respondent: Facebook, that is one of the things you go on to check keep track of your friends and things like that, that is also social aspect. Favourite website, I also check a lot of sports scores things like that on the internet when you don't have access to a TV and yes one of my favourite websites would be super sports website to check, I keep updated with things like that as well, I think that's about it.

Interviewer: **Any reasons why you like super sports other than out of interest?**

Respondent: The convenience of it and the fact that it is always updated, its just easy and quick

Interviewer: **Which website did you think was comparatively easier to use among the two?**

Respondent: The NIH

Interviewer: **Why did you think?**

Respondent: It was easier because it has the alphabets at the top, so its easier for you to actually search for something by clicking on the alphabet and then it gives you everything categorised already whereas here you will have to search for it by province and then there is so much that you got to load to find the places that you are looking for.

Appendix C: Interview Transcript - UX Designer

Interview with UX Designer

Interviewer: Shubapradha Ravi
Interviewee: Lisa Van Vliet

Ravi: I want to know a little about your professional side and what you do?

Vliet: So, I am focussed a bit more on the concept of product design as opposed to User experience design. A product designer looks at a; could be a website, could be an app it does not matter. But whatever you are offering not just as a website but we look at it as a product that has to add value or a thing, but calling it a thing is not nice, product sounds a lot better. For example this NIH senior website, it should be seen as a product because it is a product for seniors, then you can tailor it pretty much like what you are thinking about in your research to the actually people who are going to use it. I don't know if you have seen recently that user centred design has kind of been transformed into human centred design. So we are not calling it UCD anymore but HCD and the reason is because we found that calling someone a user depersonalises them but thinking about them as a human being starts to personalise them. Which leads us on to the next step of what is important in product design. You want to have empathy with your users, particularly if you are looking at seniors you have to have a lot of empathy because you are not that user at all, so we have to kind of get into the frame of mind of being able to look at the world as that kind of human being, if that makes sense. We convoluted on, that's why I am not just a UX designer but I see myself as a product designer.

Ravi: Do you design products for ABSA focussed around elderly people?

Vliet: At the moment, because we are kicking off a very big product. It is still quite generic we have not defined user groups yet. But ultimately we will define user groups and say who are. Now I have gone back to saying user groups because you always actually you do start off generic before you actually start to personalise so when we have actually given the user group or user profile and we have flushed them out into a persona then we know the humanness behind the user. We are in the pre-design phase because we have not started really designing the interface as yet. We are actually just looking at how will we start doing it.

Ravi: Have you done something earlier were you looked at something specifically for elderly people?

Vliet: It is quite a sad thing that elderly demographic is not something that we are currently looking at first. It is unfortunate that they are a demographic that kind of gets left behind a little bit. Because the emerging market and the middle market, that's unfortunately where the money is. So the counter for that argument is that when you have actually retired you have got an opportunity where you must have made a lot of money and now you have a lot of free time. Unfortunately in my industry that is not a priority because they don't see that as a user or a client that has longevity. That's why I think what you are

doing is very interesting because people don't want to have a look at over 60s first. They want to look at the 25 to 45 market first.

Ravi: When I was doing my research. I came across articles that mentioned that during a span of say 10 year there is going to be an increase in elderly population, it is surprising that you are not focussing on elderly age group?

Vliet: From a human centred design perspective we would definitely like to, but from what corporate currently sees as important. There is a balancing act between what a designer push for first and what you can then focus on over time over the lifetime of a project. I agree with you that the demographic is going to grow significantly and if we don't start catering for them properly it's a huge gap.

Ravi: During the project phase have you ever tested with elderly people?

Vliet: It depends on what we are building. Like I said we have not. I have not been involved specifically in a project that has looked at catering specifically for an elderly demographic. But what we do is we look at accessibility, so accessibility is one of our guiding principles. When you design regardless of which demographic because accessibility is important across ages because you getting like people who are blind, people who have certain defects on how they see colour. So you get different kinds of colour blindness. You can get people who are not necessarily as dexterous as the majority. We have to cater for accessibility. We need to be looking at how we tag things. How we make it easier to navigate a website and taking those accessibility principles we essentially hope. We know that there is a certain amount of catering for someone who is not in their prime.

Ravi: There are website where you can switch between interfaces depending on your age, have you ever considered this as an option while designing web interfaces?

Vliet: I would not put age as reason for switching, it would more be, I think it's the little things that do start make a difference. Take an app, instead of a website, its like something that you have to download on your phone. When you have downloaded something on your phone we know who you are because now you have to essentially create a profile, to some degree to use the app. We should rather be thinking about things we can personalise to person using it. So opposed to saying you have got over 60 segment you have to actually browse this for you. The segment of one is when you start looking at, not saying you are old so we are going to make things bigger or text bigger because that's not necessarily what that could mean. A person might still have perfect eyesight but they have got arthritis so as opposed to making the text bigger you need to make interface button bigger, make buttons more clickable then that would work well for them so I don't no if that makes sense. There is always a danger in just bracketing a demographic just according to their age, because you might over generalise . I also think that potentially although the concept of saying tagging and rebelling and how you and that people when they are older have a larger vocabulary it might also be a bit too generic. Does that mean you are catering to people who are not english speaking or it might

be something that instead of just giving them a website that is just in english you need to give them a website that they can see it in Africans, Zulu etc etc because if they don't have the vocabulary in english getting them to use a site only in english using words won't actually solve their problem. So again there comes back to looking at who the person not just what their age is.

Ravi: Could you please look at the websites and do the task that I had given the participants?

Vliet: There were people who took a long time, the participants really struggled with website and took some time.

Previous knowledge, I really like to go to Mpumalanga. So when you say Potholes, I actually knew almost it was in Mpumalanga. So for me it was easy to think I have to find province, if I can't search for "Bourke's Luck potholes" and then from there see if they have listed it as a destination. Previous knowledge always makes a huge difference to how someone interprets and starts to actually or proceeds to do a task. Because if they know nothing they will take longer.

Ravi: One participant knew that Potholes was somewhere close to Pilgrim's rest, she tried to look for it by clicking the tile Pilgrim's rest. She had the understanding and knowledge but was not successful in finding the information.

Vliet: Her mental model of what she was looking for was in relation to something else. It is one of the tricky things. When we are trying to cater for a demographic or a user group we can never, we have to have as much empathy as we possibly can but we never can be able to get into their mind to solve everything one hundred percent. Which is why when we actually, lets say in a corporate company we have a product to design, we have to kind of cause a wide net within that net we look at different slices say what am I going to do that will easiest for most people without negating the experience for a smaller subset of that demographic because if you, I can kind of think about my mom she is above 60. I know she is not the same as one of my friend's moms and their needs maybe completely different when it comes to a website that was designed for them. So how do we tackle that kind of problems. How do we say that without making it too generic or too specific.

Ravi: Any observations of NIH and SAT websites?

Vliet: This NIH website, is there a general NIH site, did you look at it

I did but it was a more general site not specific to ailments, the health info is just a small aspect of the website.

For me it is a question I would ask as a part of the research. Clearly the NIH website felt that it was important enough to do a senior health focussed website. What did they do different. It was a general website not alphabetically arranged with drop downs , etc. Health was a small part.

That is quite an interesting concept. Search-ability is very important. I like about both websites is the search is quite prominent on both websites. It is more prominent on the SAT.

Their search is pretty bad. If you type the spelling wrong it does not display results.

Information architecture is very closely related to search-ability I would find it really hard to disassociate searching from something that has information architecture related to it. Information architecture is the backbone of anything that we build. Way finding is information architecture as well. IA tells us how we find our way in a website how we find our way in an app. So search-ability the ability to not sure what I am looking for but I think its something like XYZ there should be lot of flexibility and there should be lot of forgiveness in what what comes at the back of the information architecture, where you look at potholes as one word where you look at alternatives as well. In my mind, that's what people typically do. If you are overwhelmed with the site they have to find something they search. So if they cannot immediately see it they navigate and their natural instinct is ti search. Our goal is to make as much as possible visible. But as more complicated the site becomes. You choose very good examples because they are two complicated websites. The more difficult it is for us as designers to say how will we make everything visible. Because making everything visible is kind but it also negates the reason for having information architecture. Because information architecture is supposed to bring the most important things to the top and then they you need to, what is secondary and what is potentially tertiary or what is an overview and how do I drill into more detail. Because those are the kind of things we think about in information architecture when we start off designing.

Both fundability and search-ability. Your focus is on find-ability. Because you want someone to see at a glance this is where you need to go and I think it is a very interesting approach to how do we focus on find-ability first.

You'r tagging and labelling is directly related to both fundability and search ability.

I think the NIH did a brilliant job to cater to the very basic needs that an older person would have. It comping back to me that is too simple what they did, yes changing the contrasts and toggling it between dark. Again contract is important with issues like colour blindness, even if your eye sight is failing. Maybe the contrast and the text size will help again it is step in the right direction. My problem is it is too basic with what they did. It does not take into consideration that they could be many other issues that someone who is senior needs to deal with other than eye sight. They have catered for basic eye accessibility issues. By making things bigger then become the hit areas but it does make it easy to click on but its almost like they. In human centred design the first thing and the last thing you think about is who is the first person and the last person using it and how can i make it better for the person using it. The world of design is still very far off, moving towards a concept. The idea of a persona or demographic group will fall away in the future actually. Which is why when you were asking earlier if we would build for an older

demographic we would definitely be building for them but we would not see them as an older demographic we would see them as one user as humans. One user in the sense that everyone is the same in terms of everyone is different. But the problem is that we are still far from building app or websites in that way. You were taking baby steps. Kudos to NIH for taking baby steps towards a focussed demographic or a focussed persona. SO I think they a r e doing is right but it is a very simplistic approach to it. Obviously the SAT though anyone who wants to go on a holiday in South Africa not specifically older peel or younger people, it is a super generic site they kind of went and said we want to cater for south africans in South Africa and we have to cater for anyone who comes from anyone else in the world. That is why they heavily rely on their sear which is why their search is more prominent then their menu. SAT did not make it flexible and they were not kind to their users. They did not consider the fact that people are bad spellers and bad types so we make typing errors and spelling mistakes which means you need to be kind to the users. Not everyone is gong to spell potholes as one word. Making searches flexible.

Appendix D: Thematic Data

CODE	AGE	GENDER	ANALYSIS OF STAGE 1 INTERVIEWS - PRELIMINARY ANALYSIS						OBSERVATIONS - ANALYSIS OF TASKS						ANALYSIS OF STAGE 2 INTERVIEWS				
	AGE	GENDER	COMPUTER USAGE	INTERNET USAGE	PUROPSE	FAVOURITE WEBSITE	REASON FOR LIKING	MISCELLANEOUS	TASK ON NIH WEBSITE	TASK ON SAT WEBSITE	OBSERVATION OF NIH WEBSITE USAGE	OBSERVATION OF SAT WEBSITE USAGE	TIME TAKEN TO BROWSE NIH	TIME TAKEN TO BROWSE SAT	ADVANTAGES OF NIH	DISADVANTAGE OF NIH	ADVANTAGES OF SAT	DISADVANTAGES OF SAT	DISCUSSION AROUND NIH AND SAT
Respondent 1	79	Male	Twice a week	Once a week	Facebook and typing	Facebook			Task 1 - “G” —> “Gout”	The first task __> scrolled to check the tweets and facebook mentions on the first page, this was quite confusing for him, then clicked “destination” thinking he will find a list of places, then he used “best of South Africa” to get to “colours and characters of Karoo” he still could not find the information. Takes some time to read everything that is written		He struggled quite a bit while using the mouse, especially using the menu on the SAT website	3m 20s 32ms	4m 30s 87ms	The Alphabetic thing helped		The pictures were nice	Too much to read	He did not know such websites (NIH) exists and was more than happy to look for more information. He thanked for having shown that websites like NIH exist.
									Task 2 - “C” —> “Cataract”	Task 1 - finally he used “where to go” to find information.	Though he was able to find information from NIH easily, he took time trying to read the information. The NIH was easier for him to read	The SAT website was difficult for him to read			The font size was bigger			“I took too long to find the information”	Many times people visit doctors and have no idea of the ailment, NIH website can give layman the chance to understand and get better.
										Task 2 - “guide to South Africa” —> “getting around South Africa”					The information was classified			Make the headings bold and the text bigger to improve readability	
										Task 2 - “where to go” —> “cape town” he could not find anything									
										Task 2 - he clicked followed “where to go” __> “Mpumalanga” __> Potholes									

Table 1

CODE	AGE	GENDER	ANALYSIS OF STAGE 1 INTERVIEWS - PRELIMINARY ANALYSIS						OBSERVATIONS - ANALYSIS OF TASKS						ANALYSIS OF STAGE 2 INTERVIEWS				
	AGE	GENDER	COMPUTER USAGE	INTERNET USAGE	PUROPSE	FAVOURITE WEBSITE	REASON FOR LIKING	MISCELLANEOUS	TASK ON NIH WEBSITE	TASK ON SAT WEBSITE	OBSERVATION OF NIH WEBSITE USAGE	OBSERVATION OF SAT WEBSITE USAGE	TIME TAKEN TO BROWSE NIH	TIME TAKEN TO BROWSE SAT	ADVANTAGES OF NIH	DISADVANTAGE OF NIH	ADVANTAGES OF SAT	DISADVANTAGES OF SAT	DISCUSSION AROUND NIH AND SAT
Respondent 2	77	MALE	everyday	2 hour per day	browsing - news, music, religious things	news24, BBC	BBC - very informative		Task 1 - For the first task the respondent used "bone and joints" which directed the respondent to page with keywords/tags on ailments related to bone and joints among which was "Gout", clicking this leads the user to a page with information on Gout	Task 1 - The respondent clicked "South Africa at a glance" from the menu labelled "Guide to South Africa". He struggled quite a bit and scrolled through the page, he tried to use the keywords on the right side of the page. The keywords leads the uses to different parts of the same page and not to a new page. The keywords such as "destination" was misleading. The respondent then tried to use the menu option "best of South Africa" he could not find anything related then finally he chose the menu option "where to go", followed by "Limpopo" here he could not find anything related to Karoo National Park, the respondent clicked "Kruger National park' in an effort to find information on karoo National Park. Finally he chose Western Cape under "where to go". He was then directed to a page with all the places to visit (the search was not straight forward as in case of health)	The alphabets A-Z can be made more prominent with more importance given to the button "health A-Z" the categories section can be a separate section as this sometime leads to confusion, where people think the ailments listed under categories (its purpose was to list the most commonly searched ailments) are the only ailments available on the website (maybe changing the name from "categories" to frequently browsed" will make more sense)	In order to find information related to the best time to visit karoo national park. The respondent clicks the menu "guide to South Africa" under which is the "South Africa at a glance" tab, clicking this leads the respondent to a page with a lot of general information on South Africa, along with this were keywords on the right side of the page, when he clicked the keywords or labels it directed the respondent to a section in the same page, the words and the purpose of the key words were misleading. Eg: he though clicking tourism would provide a list of places to visit in south Africa but rather it takes the respondent to a section in the page with general information on tourism in South Africa. The same with clicking the keywords 'plants and animals' the respondent though it would direct him to national parks specifically "karoo national park"	1m 10s 54ms	2m 11s 76ms	Health was easier to use than SAT			Searching was a bit difficult	
							news24 - informative, but don't rely on the news because it is South African news (not accurate)		Task 2 - For the second task the respondent used "vision and hearing" which directed the respondent to page with keywords related to vision and hearing among which was "cataract" clicking this directs the users to information on Cataract	Task 2 - for the second task the user clicked "best of South Africa" __> "top 10 places to visit", he was not able to find hence he clicked "where to go" __>'Mpumalanga" then the place, (there is only one way to enter this information), the second time the respondent used the website to find information on Potholes quite quickly. (Practice session he struggles but this task he was used to the layout and also the question asked was on the similar lines as the first question)	there are no drop downs, which was very convenient for the user	The drop down makes it difficult and confusing for people because the drop down is continuous covering the entire length of the menu bar. Making it hard for the user to distinguish if the contents of the drop down is for the entire menu or just for one of the option in the menu.			more familiar hence it was easier to use		It was in proper categories	if it was alphabetically arranged, it would have been easier to find (alphabetically arranged system will help)	
												The menu option "where to go" should have been the first menu option			if people does not know about cataract they are not going to find, so under "e" eyes they can find cataract. (this points to tag-based system where people approach a search term using varying levels of specificity)		Seems informative,	obviously one needs to read more about it, read more into it (too much information)	
												the use of action words would have made it easy							
											The menu option changes colour to indicate that the page has been visited earlier	The menu options previously visited, should be of a different colour to indicate that the person has already visited that particular page							
											The buttons are differentiated	The menu options should be differentiated, instead of it being in one line.							
											the links are underlined to indicate they are links	there is no differentiation between links and text							
											The headings were quite clear	Once the province is clicked under "where to go" in order to find places to visit in that province, a picture is displayed along with the name of the province. the name displayed is quite small. The respondent asked to confirm if he was on the right page.							
												clicking say "places to visit" followed by "wester cape" leads the user to the desired page with all the places to visit in western cape in a tiled format, this also includes a tile labelled "western cape" which was quite confusing for the respondent because he though he had not chosen "western cape". Clicking it leads the user to a general description on Western Cape, it would make sense to either remove the tile and place the general description on entering places to visit in Wester Cape itself rather than having to click on the tile.							
												The respondent was also worried that he might have missed a tile while browsing the information, he scrolled repeatedly to ensure he has not missed the tile							
												the "load more" option was confusing and the respondent failed to notice, the website should automatically load more places instead of the person having to click a button to load more places.							
												The search option is not effective, incase the person makes a spelling error it shows "results not found" and it does not predict when the user is searching for a particular place							
												The labelling of the menu could have been better or alternative words could have been used so that the users are not confused, "where to go" and 'best of South Africa" sounds similar							
												The respondent struggled to spot western Cape							
												The respondent found it hard to place the mouse on the pull down menu system							
											The bar at the bottom of the screen which displays the menu options as a list was used by non	The bar at the bottom of the screen which displays the menu options as a list was used by non							

CODE	AGE	GENDER	ANALYSIS OF STAGE 1 INTERVIEWS - PRELIMINARY ANALYSIS						OBSERVATIONS - ANALYSIS OF TASKS						ANALYSIS OF STAGE 2 INTERVIEWS				
	AGE	GENDER	COMPUTER USAGE	INTERNET USAGE	PUROPSE	FAVOURITE WEBSITE	REASON FOR LIKING	MISCELLANEOUS	TASK ON NIH WEBSITE	TASK ON SAT WEBSITE	OBSERVATION OF NIH WEBSITE USAGE	OBSERVATION OF SAT WEBSITE USAGE	TIME TAKEN TO BROWSE NIH	TIME TAKEN TO BROWSE SAT	ADVANTAGES OF NIH	DISADVANTAGE OF NIH	ADVANTAGES OF SAT	DISADVANTAGES OF SAT	DISCUSSION AROUND NIH AND SAT
Respondent 3	76	FEMALE	Everyday	2 hours per day	cooking, health issues, household (information and communication)	Youtube and google	visually I can see what I am looking for - youtube	From google I go to Youtube	Task 1 - The first task “bone and joint” then ‘Gout”	The first task __> scrolled to check the tweets and facebook mentions on the first page, this was quite confusing for her, then clicked “destination” thinking she will find a list of places, then she used “best of South Africa” to get to “colours and characters of Karoo” she still could not find the information. Takes some time to read everything that is written finally she used “where to go” to find information.	The NIH website indicates the path taken by the user to reach a particular page. This is pretty small and goes un-noticed. This can be improved with the use of bigger and bolder letters or a pop-up which indicated the path taken by the user		2m 30s 67ms	4m 10s 54ms	Health was easier than SAT		Pictures were nice	SAT was difficult to use	
							google will give the exact information if I am not looking for visual information	go to youtube and type words then browse and then select	Task 2 - button labelled “health topics A-Z” then “c” then Cataract. She also checked under letter “a” “age-related muscular degeneration”	Task 2 - “guide to South Africa” —> “destination” —> took a long time to read	The user searched for other ailments that were relevant to her apart from what was asked, out of curiosity.	She got it write the second time			I like the information format on NIH			Have to keep searching and go “again and again” (keep going back and forth and trying to remember the interaction)	
								Internet is like a friend		Task 2 - “guide to South Africa” —> “getting around South Africa”	The NIH was simple and straight forward to use	The home page was confusing						Not friendly	
								you can ask anything and it will give you the information		Task 2 - “where to go” —> “cape town” she could not find anything		the drop downs were not easy to use							
										Task 2 - She clicked followed “where to go” __> “Mpumalanga” __> Potholes		the load more option was making it difficult for her							
												she had to make sure she has not missed tiles while browsing							
												the pull ups - hovering on the tiles caused a lot of confusion							
												going back to the home page was challenging for her							
												She could not differentiate between clickable links and headings							

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Respondent 4	73	Female	yes, little	daily about 2 hours	Social media, news abroad	Spiritual website	informative		Task 1 - “g” __> “gout”	Task 1 - “best of South Africa” she searched the menu options like “world heritage sites” then “what to do” then went to “where to go” then she clicked “Norther Cape”	She had no problem with NIH website	The respondent took quite some time to read through the various menu options which was time consuming	0m 28s 11ms	1m 24s 30ms	Health was easier			should be more precise with touristic places	
					especially India		upto date		Task 2 - “c” __> “Cataract”	Task 1 - then she clicked “richerveld botanical landscape” because the picture looked like Karoo national park		The old more option went un noticed			because of alphabetical index			I struggled a bit	
							current			Task 1 - “guide to south Africa” __> “getting around South Africa”		re checking to see if non of the tiles were missed							
							language used is simple			Task 1 - Finally she clicked “where to go” then “western cape”									
										Task 2 - “where to go” __> “Mpumalanga” __> “Pligrim’s rest” (spent quite sometime thinking Potholes was in Pilgrim’s rest) then went back		(Generating words and equivalents of the given question, Pligrim’s rest is closer to Potholes hence she though this page should contain information, technically it should have contained information)							

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Respondent 5	72		everyday	everyday	Spiritual	I like reading about spirituality			Task 1 - “bone and joints” __> “gout”	Task 1 - “Guide to South Africa”	no difficulty either in the practice or the timer task. people automatically got accustomed to the site in the first attempt	Did not notice load more option	2m 44s 14ms	4m 11s 49ms	Health was better than tourism			The block aspect of the website was a little distracting/ confusing	She said she was not reading properly and paying attention which was why she found using SAT difficult
					Home based remedies for ailments	stories			Task 2 - “vision and hearing” __> “cataract”	Task 1 - “Where to go” __> “capetown” —> could not find anything related		People took time to understand how the site functions, they faced problem even after getting accustomed did not know where they previously clicked (Spatial ability) and also			the health it was right there in front of you, do not have to read very hard to find information				She felt if a person was computer literate it should not be difficult to find information
										Task 1 - “where to go” —> “western cape”		The labelling often confused people who do not use website frequently			All information was laid out in front of you				The tourism could have also had alphabetical arrangement
															Straight forward				
										Task 2 - “where to go” __> “Mumalanga highlights” tile was confusing,					The older generation like me would find it easy because of the alphabetical arrangement unlike the younger generation	The first time she did not notice A-Z health topics she felt the “categories” label distracted her from the main focus which should be the alphabetically arranged system			She did not know such websites existed, she was happy to use it and look further for more information related to a disease that her son suffers from
										Task 2 - “where to go” __> “Mpumalanga” —> “Potholes”					The health information was line by line				

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Respondent 6	71	FEMALE	EVERYDAY	3 HOURS PER DAY	medical aids, practitioners, facials, weight loss, exercising	Youtube			Task 1 - The first task the respondent clicked “bone and joint” then “Gout”	Task 1 - She clicked “kruger national park” under “where to go” thinking she might find “Karoo national Park” . Later he took the usual path “where to go’, clicked “cape town” —> then “where to go” —> “western Cape”	Both the practise and the timer task were easy	People tend to recognise words when asked for information	0m 52s 40ms	1m 11s 40ms	Health was easier to use than SAT		also user friendly, all informations were there	The names of the places are not bold	
									Task 2 - The second task the respondent clicked “health topics A-Z” then selected “vision and hearing” then “cataract” (the first time she missed the button option given to her) the second time she was able to find it) (then followed “vision and hearing - cataract)	The second task she took the usual path “where to go’ then the province then the place. (She had got used to the layout)		The load more option was a problem			it was a good website and easy to work,			Spent a lot of time because I had to read through a lot of information	
												The drop down option was a little difficult to use			the way the information was organised into alphabets was nice				
												The headings were not clear and distinguishable - for the timer task she clicked “where to go” followed by “Mpumalanga” twice because she was not sure if she was on the page with places to visit in Mpumalanga. The heading could be bold and distinguishable in order to find quickly (better contrast with pictured background)							
												She asked if she was on the right track							
												While she took time to do the practice task (SAT), the timer task was pretty easy because the question asked or the task given were on the similar lines as the first task							

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Respondent 7	69	Male	Everyday 6-8 hours	yes 1 hour	Technical and news	News24	user friendly		Task 1 - “G” __> “Gout”	Task 1 - “Guide to South Africa” __> “destinations” then “where to go” __> “WesternCape” __> Karoo National park	The user either tries to relate words say for example “Gout” while some searched fur “bone and joint” others searched fur “Gout” itself	The same is the case with SAT website	49s 21ms	1m 10s 21ms	The alphabetical index helped		South African tourism was easier to use than health website		Content wise both websites were same
				Internet usage is critical			categorised information		Task 2 - “C” __> “Cataract”	Task 2 - “where to go” __> “Mpumalanga” __> Potholes	They tried to recognise and co-related words and generate words mentally						appealing		in terms of Look and feel tourism they had done a better job
				to get information on education, health, academics and non-academics, sports		Google	solve Technical challenge				The user was concerned more with the performance of the website, at some point during the task the performance in NIH website slowed due to server issues / internet connectivity issues	The performance of SAT website was better during this interview					comfortable in terms of usability		The user was also concerned with the performance of the website
				internet is information based			Easiest way to get information										better performance		
				any information can be obtained			any information google can provide												

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Respondent 8	67	Female	everyday	it varies	Teach spiritual education	Google	I just search using Google		Task 1 - “k” __> “Knee” __> “Gout”	Task 1 - “best of south Africa” __> “top 10 regions” (could not find) then “where to go” __> “WesternCape” __> karoo National Park			0m 18s 29ms	1m 56s 38ms	Health better than SAT		The pictures were beautiful	But for my age I had to read a lot of information and it seemed cluttered	
				I cannot live without internet	Stories for grandson	I go ahead with whatever content I am looking for	Permutation and combination search until I get what I am looking for		Task 2 - “c” __> “cataract”	Task 2 - “Guide to South Africa” __> destination (could not find) “where to go” __> “Mpumalanga” __ “Potholes” (depends spatial ability the person has to remember which tab he visited previously)	By highlighting previously visited tabs/ menu this confusion can be avoided. The person had to remember which menu option he visited previously, in this case the user forgot while doing the second task though the second task was on the similar lines of the first task				Whatever I was searching for was available in the index				
						Nothing in particular					Load more option posed a problem								
											The menu structure was difficult to use								

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	AGE	GENDER	COMPUTER USAGE	INTERNET USAGE	PUROPSE	FAVOURITE WEBSITE	REASON FOR LIKING	MISCELLANEOUS	TASK ON NIH WEBSITE	TASK ON SAT WEBSITE	OBSERVATION OF NIH WEBSITE USAGE	OBSERVATION OF SAT WEBSITE USAGE	TIME TAKEN TO BROWSE NIH	TIME TAKEN TO BROWSE SAT	ADVANTAGES OF NIH	DISADVANTAGE OF NIH	ADVANTAGES OF SAT	DISADVANTAGES OF SAT	DISCUSSION AROUND NIH AND SAT
Respondent 9	66	Female	entire day	everyday , often	I am a curious and inquisitive person	new24	organised, local news, international news or sports news		Task 1 - “bone and joint” —> “Gout”	Task 1 - “Guide to South Africa” —> “destination”	Had no issues with NIH website. used it with ease		1m 11s 62ms	2m 9s 22ms	NIH was more categorised for what I was looking for			Read through a lot of text to get to the answer	NIH can have some pictures to make it interesting
					news	Google	whatever google direct me to		Task 2 - “health A-Z” “C” —> “cataract”	Task 1 - “Guide to South Africa” —> “getting around South Africa”									
					accessing information	Woolworths	intuitive			Task 1 - “where to go” —> “cape town”									
					online shopping		graphics			Task 1 - “where to go” —> “western cape”									
					research		helps visualise			Task 2 - “best of South Africa” —> “colours of Karoo”									
						News24	easy to navigate			Task 2 - “where to go” —> “western Cape”									
										Task 2 - “where to go” —> “Mpumalanga” —> “Mpumalanga highlights”									
										Task 2 - “where to go” —> “Mpumalanga” —> “Pligrim’s rest”		Missed the Potholes, did not notice that it was there							
										Task 2 - “where to go” —> “Mpumalanga” —> “Potholes”									

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Respondent 10	64	Male	all the time	most of the time	products	own company website			Task 1 - “G” —> “Gout”	Task 1 - “best of South Africa” —> “top 10 regions”	Had no difficulty with health website	The names were mis-leading	0m 26s 51ms	0m 50s 94ms	NIH was easier then SAT		Visually better appeal	Loading pages	If you know where to look its fine but other it was a bit difficult to use - SAT
					services				Task 2 - “C” —> “cataract”	Task 1 - “where to go” —> “Westerncape”	Browsed with ease				Structured			Too much information	
					research					Task 2 - “guide to south Africa” —> “destinations”					Searching for information is better on tourism website			Better categorisation	
										Task 2 - “where to go” —> “Mpumalanga”					Alphabetical order helped			better classification	
																		Navigation was hard	

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Respondent 11	62	Female	3 - 4 times	2-3 hours	Book things		one with lot of pictures		Task 1 - “G” —> “Gout”	Task 1 - “best of south africa” —> “top 10 regions”	Quite easy to find information	Missed the load more option	0m 27s 54ms	0m 44s 48ms	NIH was easier to use than SAT		I will spend more time on tourism out of curiosity	Lack of filtering option to check most visited or places to visit is the coming month (seasonal) etc	IN SAT they do’t want you to go and find answer to a particular
					entertainment		visual ideas		Task 2 - “C” —> “Cataract”	Task 1 - “guide to south africa” —> “destinations”		Checked if a tile has missed			it was structured				The SAT wants you to surf, they want people to see all those pictures
					social		videos			Task 1 - “where to go” —> “cape town”		though twice before clicking the desired link			the information was designed keeping in mind the person searching finds answers easily				IN NIH - their main agenda was if they have an ailment, you want to know what to do to get to the point quickly (it is straight forward)
					earlier for research work (before retirement)		Did not like written script (text on website)			task 1 - “where to go” —> “western Cape”					I would go to health only if I have an ailment				The tourism is like shopping where in pick n pay they do not keep the bread and milk together
					ideas for food presentation					Task 2 - “where to go” —> “Mpumalanga” —> “mpumalanga highlights”					Health was straight forward				The tourism instead of listing all places they could have most visited
					decor ideas					Task 2 - “back” —> “POtholes” (checked again did not find it the first time found it the second time)					It can’t get easier than A_Z, click alphabet the disease starts with then you have the information				If I am searching in Fab ideal places to visit in March
																			SO that i may not have to read everything to know that

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Respondent 12	61	Female	everyday	everyday	emails	Facebook	keep track of friends		Task 1 - “G” —> “Gout”	Task 1 - “where to go” —> “cape town”			0m 40s 78ms	2m 25s 34ms	NIH better than SAT website			you have to search by province	
					information	super sports	updated		Task 2 - “c” —> “cataract”	Task 1 - “where to go” —> “western Cape” (again clicked “where to go and then “western cape”)		Not sure if the page loaded, did not observe the text which said “western cape” on the website (the letter could have been eligible)			The alphabets at the top made it easy to use			too much to load to find places you are looking for	
					social things		convenience if there is no TV			Task 2 - “destination” (did not find anything relevant)		Did not notice the “Load more” option which loads more places to visit			easy to click on the alphabet			too much information presented	
					restaurants		easy			Task 2 - “where to go” —> “Mpumalanga” —> “Potholes”		Making sure if she had not missed any tile			everything is categorised				
					book tickets		quick												
					sports														