# Quick Reading Strategies in Using Screen Readers

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## Abstract
Skimming and scanning allow readers to extract the essence of the information without reading the whole text. In this research, we conducted task based observation studies to understand quick reading strategies used by screen reader users in the absence of proper semantic information in a webpage. We found that screen reader users use different quick reading strategies for large content such as webpages, and small content such as article sections. They use alternate strategies in the absence of a headings or links list, and often rely on their own memory to scan. Based on these findings, we present design considerations for screen reading technology that would enable quick reading in web-pages that may or may not be semantically organized.

## Author Keywords
Reading strategies; Screen readers; HCI; skimming; scanning; non-visual web access; Web accessibility

## ACM Classification Keywords
K.4.2 Computers and Society: Social issues (Assistive technologies)

## Introduction
Quick-reading methods (also known as skimming and scanning) aim to "enhance the rate of reading without compromising comprehension and retention of information"[1]. Skimming is a skill that can be helpful in deciding if a text deserves careful reading. Scanning involves searching for specific information, based on gist obtained from skimming[7]. Sighted individuals can visually skim through text content to extract the essence of information. Skimming saves time and reduces cognitive load[1]. However, people who are

blind do not have the ability to visually skim and scan; instead they use screen readers using multiple strategies [3].

In this project, we investigated how people who were blind skimmed and scanned web-based data using screen readers. Research has established that people who are blind navigate web-based content sequentially, often first through headings [4]. Screen reader users also have the ability to read content by paragraph, line or word. However, there are several problems with these methods for skimming and scanning pages.

First, many pages are not coded correctly[2]. A 2016 study of 8 million index pages showed that a minor percentage of webpages use semantic tags such as section, nav, header, footer[10]. Second, users listen to auditory information from their screen readers at a very high speech rate [5]. This allows users to go through given content quickly, but can lead to an information or cognitive overload [1]. We found three studies that investigated skimming interfaces for people who are blind.

In two of the studies of skimming interfaces, the researchers used  algorithms to summarize the text presented in the  HTML code [6,8]. After testing with blind and sighted participants, they concluded that the content generated by skimming interface is more satisfying than the original content. Related, Takagi, H., & Asakawati [9] devised a transcoding system to generate summarized pages for non-visual web access. They suggested that volunteers could help adopt this system across websites[9].

These proposed solutions for summary creation rely on the HTML structure of webpages, and do not consider the fact that many pages are not coded correctly. Moreover, these studies do not consider the methods used by screen reader users. Our findings highlight the reading strategies used by screen readers in navigating web content which may or may not organised semantically. Based on these strategies, we have provided design considerations for screen reading technology that enable screen reader users to skim and scan web pages more efficiently. In the next sections, we present our methods, findings, and design implications.

## Methods

In this section, we present our participants, and our data collection and analysis methods.

*Participants*

We conducted task-based observation studies and inquiries with participants who are blind to understand how they skimmed and scanned digital content using their screen readers. We recruited four participants between ages 33 - 69 for the study. All participants were recruited from the Chicago area; all used windows-based computers. Three participants used the JAWS (Job Access with Speech) screen reader and one (John) used NVDA (Non-Visual Desktop Access). See Table 1 for a summary of the participant demographics.

| Participant name | Age | Mobile, AT | Laptop, OS,AT |
|---|---|---|---|
| John | 33 | iPhone, VoiceOver | Dell, Windows OS, NVDA |

| | | | |
|---|---|---|---|
| Tina | 64 | iPhone, VoiceOver | HP, Windows 7, JAWS v18 |
| Lola | 56 | iPhone, VoiceOver | HP, Windows OS, JAWS v17 |
| Megan | 69 | iPhone VoiceOver | HP, Windows JAWS |

Table 1: Participant demographics

*Data Collection*

We conducted studies with John and Lola at Second sense, a computer training center for people with visual impairment in Chicago Illinois. The study with Tina was conducted at DePaul University's Loop campus and Megan's study was conducted at her residence. We obtained participation consent before the study. Each study took 45 minutes. We took notes and audio recorded the session for later transcriptions.

All participants used their screen readers in the speech rate they typically use. John used NVDA at a 70% speech rate; Tina, Lola, Megan used JAWS at a 50%, 60%, and 57% rate respectively.

We asked participants to complete three scenario-based tasks on a Wikipedia page: https://en.wikipedia.org/wiki/Mickey_Mouse. We chose this webpage because it displayed a lot of digital content; text, headings, links, tables, figures. Additionally, the content was not neatly organized into a headings or a links list. This encouraged participants to use alternate strategies than those that they used with well designed and well-coded pages. Participants were asked to demonstrate the following scenarios:

1. **You found this webpage online that may be related to your research. You want to see if it is relevant to you**; participants were given a 5-minute time frame to complete the task.

2. **The section "design" may be relevant to your research. You want to take a quick look to see if it is relevant to you**; participants were given a 2-minute time frame to complete the task.

3. **You want to find two specific phrases from the webpage and the "design" section, that are relevant to your research;** if participants used search or find, they were encouraged to explore other methods.

After completing the first and second task, we asked participants what they remembered from the webpage. After each scenario, we asked participants to describe their methods. We asked participants to describe any additional methods they might use in such scenarios.

After the scenario-based task observations, we asked participants how their reading strategies change with different content; specifically, eBooks, web pages, emails. At the end of the study, participants were given a $10 gift card for their participation.

*Data Analysis*

We organized notes from our study using an affinity mapping method. We found recurring patterns in the types of reading strategies our participants used. We combined those patterns into themes.

## Findings

In this section, we present quick-reading strategies used by participants : (1) skimming: assessing given information to understand relevance, (2) scanning: finding relevant information identified from skimming, (3) other browsing strategies.

*Skimming: Assessing given information to understand the relevance*

We found that participants used a variety of methods to analyze given content, without reading the entire text. Participants used different strategies based on the scope of the content.

***Skimming through large content; webpage***: All Participants' first strategy was to go through the list of headings. For instance, John mentioned that the headings help him "quickly go through all the content". Based on the headings, he would decide if he wants to explore the page further. John and Megan mentioned that in order to grasp the content of the page, they first have to assess the layout or the composition. Megan stated that she used headings to understand the "high-level layout of the page." After she understood "what the page looks like", she would read further.

After Participants used headers to skim the page, we found that their next strategy was to skim through the links. For instance, Megan mentioned that "links provide context" and help her "better understand the page and the layout." She said that "links are important especially when I am trying to get to a particular part of the page." Participants further elaborated that inaccessible links would discourage them to use the webpage.

When participants couldn't find a headings or links list, they used alternate strategies. For example, John and Tina used the "T" key to tab through tables. John elaborated "If there are no headings, look for links, or tables, or image captions", in order to assess web page content. Lola tabbed through image descriptions to skim through the webpage. Similarly, Megan said "sometimes graphics can also provide some useful information. Of course, this only happens when there is sufficient alternative text."

***Skimming through small content; section of a webpage***: When asked to read a smaller section of the page, we found that Participants used other quick reading strategies. Reading by line or by paragraph was a common method. John, Tina, and Lola mentioned JAWS skimming feature; it reads the first and last line of a paragraph. None of them used it.

All participants used selective reading strategies by skipping content. For example, John and Lola read the first few paragraphs before navigating through the page. Tina skipped lines and paragraphs that were not relevant to her as "it does not give [her] much information."

All Participants mentioned the JAWS cursor, however, only Tina utilized the feature during our observations. JAWS cursor works as a keyboard controlled mouse, to help navigate web page contents.

*Scanning: Finding relevant information identified from skimming*

This section discusses the methods used by participants to scan content using screen reader affordances, and using their memory.

***Screen Reader Affordances***: All Participants mentioned versions of bookmarking features. Most participants mentioned using the Bookmark feature to save web pages. However, none of the Participants remembered how to Bookmark a page. Tina mentioned bookmarking useful headings, and Megan mentioned bookmarking links. Tina said that she often accesses the list of visited links, to go back to a desired link.

Megan used the Place Marker feature to "tag the text." She explained that the Place Marker feature helps her to quickly go back to desired sections on the page, saying "I use it all the time at work". Lola and Tina mentioned a bookmarking shortcut for text, that could be helpful. But they didn't know how to use it.

Lola and John mentioned copying important text to a document, to access later. Lola said "I bold or highlight important phrases."

***Using Memory***: All Participants relied on their memory when asked to refer back to a section of the page. For example, John recalled certain words and phrases on the web page, to use the search. Similarly, Lola "picked up important words" and used the Find feature to navigate to different paragraphs.

Both Lola and Tina said that they would remember the first word of a sentence or paragraph containing something relevant. Lola said "If I need to remember something important, I remember what the sentence started with." They mentioned following up by using the Read by line or paragraph method to find the word. Tina mentioned remembering the first letter of list items, and using the "first letter navigation" shortcut.

Lola and John mentioned remembering the position of a specific word within a section. They mentioned using the Arrow up or down lines to reach where they wanted.

*Other browsing strategies*
Lola mentioned multi-tasking to save time while conducting internet activity. She said "I always listen to multiple things; news, email, a recipe, and i'll use selective hearing to concentrate where I want".

## Discussion

In our study, we found that participants used both screen reader affordances, and their own strategies to employ quick reading.

Most common methods of skimming to assess a webpage included using the headings or links list. When the lists were unavailable, participants assessed the web page through tables, images, graphics. Participants used the Read by line, or paragraph feature to skip content in quick reading smaller sections. Some participants mentioned the JAWS skimming feature to read first and last line of a paragraph.

With respect to scanning for relevant information, most participants mentioned bookmarking relevant links and headings. One used inline bookmarking. Some said that they copy important text to another document. Participants relied on their memory to find specific information. Two said that they remembered the position of the text within a section, arrow up or down to it. Two mentioned that they remembered the first word of the line or paragraph that contains the information they need.

In the following sections, we propose some design implications for screen readers to help users employ quick reading. We also state limitations of our study, and future work.

*Implications on design*
In this section, we present design considerations for screen reading technology to enable screen reader users employ quick reading.

Screen readers should allow for easy inline bookmarking. Thereafter, it should allow users to retrieve those bookmarks when required, easily. The bookmarks could be numbered for easy identification.

Screen readers should allow users to use a "Skip" option to move to the next word, line, paragraph or section. We observed that participants often used this method manually by stopping voiceover; however, using a skip shortcut will allow them to get to the section that they are looking for quickly.

Participants mentioned copying relevant information to an external document. We suggest that screen readers should enable users to select text or content that is relevant to them. The selected text can be automatically copied into a temporary file. Users can then access this file to only read the sections they selected.

Additionally, artificial intelligence and computer vision can help identify headings that are missing key semantic information. Screen readers can use this to interpret layout of the content, and help users access what they need.

*Limitations and future work*
The limitations of this study included a small sample size (n=4). Three of our participants were above the age of 55. We did not have enough representation of participants of a younger age group. This factor may be important because a younger age group may have more interaction with digital content. We did not consider the types of reading activities participants interact with  on a regular basis. Furthermore, our study only considered content included in one type of webpage.

Future studies would involve testing with a larger sample. We would make sure to include participants of a more diverse age group. We may also consider users' experience with reading digital content. Users who engage with more digital content may have other strategies that would inform the design considerations in screen readers.

We are interested to observe how users interact with other types of digital content( e.g.: email, eBooks). It will be beneficial to observe the strategies that they use in engaging with other types of content. Furthermore, we are interested to know how users interact with touch screen devices to access content. Interaction with assistive technology on a touch screen device might give us more insight into the strategies used by screen reader users.

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