

Readers' experiences of Braille in an evolving technological world

Article

Accepted Version

Marshall, L. and Moys, J.-L. (2020) Readers' experiences of Braille in an evolving technological world. *Visible Language*, 52 (1/2). ISSN 0022-2224 Available at <https://centaur.reading.ac.uk/88728/>

It is advisable to refer to the publisher's version if you intend to cite from the work. See [Guidance on citing](#).

Publisher: University of Cincinnati, School of Design

All outputs in CentAUR are protected by Intellectual Property Rights law, including copyright law. Copyright and IPR is retained by the creators or other copyright holders. Terms and conditions for use of this material are defined in the [End User Agreement](#).

www.reading.ac.uk/centaur

CentAUR

Central Archive at the University of Reading
Reading's research outputs online

Readers' experiences of Braille in an evolving technological world

Laura Marshall and Jeanne-Louise Moys

Abstract

This paper investigates people's experiences and opinions of Braille as a reading method. It aims to explore how Braille's role may be evolving in a world with an increased range of technological alternatives for reading. Two participant studies with people with visual impairments are reported. Firstly, a survey (Study A) explores current reading experiences and preferences. Secondly, building on the survey findings, a series of in-depth interviews (Study B) explores individual reading experiences of different artefacts. The findings show how particular assistive technologies may be deemed more or less appropriate for different reading contexts and purposes and highlights issues of production and standardization for reading artefacts. This suggests that providing people with visual impairments with access to a range of resources could support more inclusive practices. The findings also suggest that in some contexts, such as information presented in public spaces and on packaging, greater standardization of Braille could be of benefit to people with visual impairments.

1 Background and rationale

Since its invention in 1824, Louis Braille's six-dot tactile reading system has evolved into a variety of Braille alphabets across the world (Papadimitriou and Argyropoulos, 2017). Braille is currently used by over 150 million people globally (Royal Blind, 2018a). It has two forms: Grade 1 (alphabetic or uncontracted) and Grade 2 (contracted) (Roe et al., 2014).

Technological advances are allowing for Braille to be read and written much faster and introducing a range of alternatives to traditional Braille. Examples include refreshable electronic Braille displays and screen readers, which can be used with audio output. This paper explores the reading experiences and preferences of Braille users in order to understand how Braille usage may be changing and to identify considerations for more inclusive practice.

2 Theoretical and contextual foundations

Braille literacy has decreased since the mid-twentieth century and now seems to be used by less than 10% of students with visual impairments (Graves, 2018; Braille Works, 2016; Roe et al., 2014; Ferrell et al., 2006). This figure may differ for older demographics as many people who lose their sight later in life may choose not to learn Braille. Furthermore, there is a vast range of visual impairments and reasons why a person may go blind. Some of these have particular implications for accessible reading methods. For example, age-related eye diseases (one of the biggest causes of blindness) and diabetes can lead to reduced finger sensitivity. This may mean Braille is indiscernible to many individuals with visual impairments.

Nevertheless, Braille is an essential literacy medium for people who are blind and/or deaf-blind. Reading Braille is considered an active process that gives individuals an understanding of mark-making and formatting as well as learning spelling and punctuation (Royal Blind, 2018b; Emerson et al., 2009).

Studies support the relationship between Braille and literacy (Emerson et al., 2009; Roe et al., 2014). Papastergiou and Pappa (2019, 16) suggest that children with visual impairments may even perform better in reading (with Braille) and auditory comprehension tasks due to the development of 'memory skills and tactile tactics in order to compensate for their sight absence.' There is also a range of evidence to support Braille having clear benefits for increasing employability, independence, confidence, and self-determination for people with visual impairments (Farrow, 2015; Ryles, 2000; 1996; Schroeder, 1996). For some, Braille education is deemed a freedom of speech issue because it is 'integral to their literacy and, by extension, their expressiveness' (Engelhart, 2012, <https://bit.ly/2FwvSsg>).

However, some writers also note that Braille 'carries a stigma' and can be very 'time-consuming' to learn for adults whose vision may have deteriorated (Farrow, 2015, 318). Recently, Unified English Braille (UEB) has been introduced and adopted as a national standard in 'all the major English-speaking countries' (Tobin and Hill, 2015: 241). UEB was released to create a single Braille code to be used across literary material, mathematics, and computer notation (Cryer et al., 2013), but new users may also need to learn Standard English Braille (SEB) if they wish to access older printed literature. UEB aims to try to reduce differences between, for example, UK and US Braille codes and make reading of overseas Braille resources less challenging than it may have been in the past. The uptake of UEB seems to be more rapid than anticipated (D'Andrea, 2018), which may indicate that Braille is becoming more accessible, affordable, and practical for users (Tobin and Hill, 2015).

Not all books and magazines are transcribed into Braille and Braille editions are often published a long time after their printed counterparts. Only 7% of all published books are available in Braille or other alternatives for people with visual impairments. In addition, Braille literature can be bulky and often has to be split into several volumes (RNIB, 2018).

In contrast, refreshable Braille displays offer an immersive and tactile reading experience, without the need for bulky paper resources. Candido (2008) and Tobin and Hill (2015) highlight a number of advantages of the Internet and digital technologies for learners with visual impairments. Screen readers seem to be emerging as the primary tool people with

visual impairments use to access digital information (Verma et al., 2012). Audio screen readers enable users to navigate the Internet. They are a cheaper/free alternative for those who cannot afford a refreshable Braille display, or who cannot read Braille. Keyboard commands allow the user to skim the text for the relevant information. For example, they can listen to the first few words from each paragraph or page to allow for selective reading. However, the very nature of audio means it may not be suitable for use in all situations. In addition, the efficiency of screen readers relies on websites following accessibility rules and many websites are still not fully accessible (IONOS, 2018). Lack of alt text in the HTML structure, hidden content, and missing headers can make navigation challenging (IONOS, 2018).

With the increased availability of other assistive technologies for reading, researchers have begun to compare people's experiences and preferences of paper Braille and assistive technologies. The majority of these studies seem to be carried out in educational contexts with school children or students. For example, D'Andrea (2012) explored how 16–22-year-olds are using paper Braille and assistive technologies for classroom learning and their attitudes towards these tools. Their findings highlighted the 'importance for students of being able to make choices regarding tools and strategies' (D'Andrea, 2012, 585).

Schölvink et al. (2017, 204) express concern with our 'visually oriented society' and the sighted population's increasing reliance on icons, maps, and other visual cues in everyday communication, particularly in digital and wayfinding contexts. In wayfinding contexts, Braille may often be absent or inconsistent in its positioning (Tobin and Hill, 2015). On the other hand, Braille also remains the only dual reading and writing system for personal use (Tobin and Hill, 2015). Braille provides privacy that audio devices do not offer, particularly in some public spaces, and allows for easier navigation without assistance.

There are a wide range of reading methods and assistive technologies available, which in turn, have their own set of advantages and disadvantages. As the majority of studies seem to focus on young people in educational contexts, we set out to engage with a wider range of adult Braille users and explore their reading experiences and preferences across different genres and contexts. As Braille is used by less than 10% of students with visual impairments (Graves, 2018; Braille Works, 2016; Roe et al., 2014; Ferrell et al., 2006), younger readers' preferences may be heavily influenced by their proficiency in Braille. Users who have been familiar with the medium for a long time will have had longer to develop practices and preferences, including their experience of new assistive technologies, the evolving Braille code, and the recent UEB implementation. It is also important to consider how their behavior and preferences may change across multiple genres and contexts.

3 Methods

3.1. Aim

We aim to explore people's reading experiences and preferences and to identify how Braille's role may be evolving in relation to new alternative reading technologies. We conducted two interrelated studies to consider whether people's assistive technologies preferences change for different information contexts and genres.

3.2 Participants and research design

We invited members of the Braillists (2018) organization – a forum for people with interest in Braille – to participate in our research. The Braillists is based in the UK, but the online forum is used globally. We invited forum members to participate in an online survey (Study A). The survey was sent to 55 volunteers who stated interest in the project after communication on the Braillist forum. The survey was active for two weeks and had 38 respondents. The survey

was hosted on a well-known online platform and was pre-tested to ensure it was accessible with a screen-reader. A few forum members noted that they had problems accessing it, so it would seem that it was not sufficiently compatible with all screen-readers. Over 50% of participants were over the age of 50. As existing research has mainly focused on a younger demographic, exploring the opinions of this demographic could illuminate some considerations for our aging society.

Building on the survey findings, a series of face-to-face semi-structured interviews (Study B) explored individual reading experiences with participants from Study A who had previously indicated that they would be willing to collaborate further at a Braillist event. The interviews were held in an accessible location with step-free access and the room was set up to ensure participants would be able to interact with the resources easily on a stable surface (table). Ensuring the room had vast natural light was necessary for participants with partial sight. It was also crucial that the testing surface was clean as dust or dirt could negatively impact the reading material and therefore the reading experience. Communication was the most important factor to ensure participants felt comfortable and reassured during the interview. Five people participated, three of whom were accompanied by a carer. All participants could read Braille, and one participant had usable sight for reading. Small samples are typical of many studies with participants with disabilities. While this means the findings of Study B may not be broadly generalizable, they suggest several relevant considerations that could inform the kinds of questions and artefacts examined in future studies.

3.3 Study A

The aim of Study A was to explore the reading preferences and experiences of people with visual impairments who use Braille. The survey explored participants' reading experiences and preferences, using a combination of multiple-choice, multiple-answer questions, scales of agreement, and a few open-ended questions. The survey began with six questions to ascertain what kinds of disabilities participants experienced, their Braille proficiency, and UEB use. Participants were then asked a series of four multiple-choice questions to identify how frequently they read for pleasure, work, to keep up with news and events, or to navigate. They were also asked seven multiple-answer questions to explore what reading technologies they have used and their technology preferences in relation to different kinds of reading: literary texts (novels and non-fiction), news articles, educational texts, reading for navigation, email, and reading while commuting or travelling. Participants were also asked to share their views on:

- Braille's potential influence on their quality of life (open-ended question),
- the importance of Braille for literacy (rating scale followed by an open-ended question to explain response),
- the impact of UEB on Braille use (rating scale followed by an open-ended question to explain response), and,
- the future of Braille (open-ended question).

The survey concluded with an opportunity for participants to include any additional information they deemed relevant to share.

3.4 Study B

Participants were questioned about their reading behaviors, methods, and preferences across professional and leisure contexts, as well as their views on the future of Braille. They were also asked to bring and discuss examples of material that they deemed to be: 'easy to read,' 'difficult to read,' as well as, if appropriate, an example of a device they use for reading. Asking participants to bring their own materials was important to ensure participants could discuss materials they are familiar with and could open up the range of examples shown beyond those chosen by the researchers.

Participants were also shown some additional examples from different genres supplied by the facilitator. We anticipated that participants might be inclined to bring examples designed for continuous reading. In line with our aims to consider a broad range of reading practices, we sourced examples to represent: a range of reading contexts, two types of Braille (Grade 1 and UEB), and to show varying amounts of Braille on a range of surfaces. Two UEB Braille magazines, an award-winning children's book in Grade 1 Braille, and four packaging examples (box of tissues, biscuit packaging, ferrous sulphate tablets, and shower gel) were provided for the participants to examine and discuss. The packaging examples were sourced from the only UK supermarket that currently includes Braille on all their own brand products. For each supplied example, participants were asked to: read Braille parts aloud, comment on the ease of reading, and share their views on how these might be used in everyday contexts.

3.5 Data analysis methods

Study A provided mainly quantitative data, allowing for meaningful comparisons to be made as well as exploring common opinion and preference. Due to the noted accessibility problems with the survey platform, the data underwent necessary data checks to remove outliers and responses which were input in incorrect answer fields. Descriptive statistics, such as percentages and frequency, were used to summarize the data and consider different groups of participants, such as users varying in Braille proficiency. The numerical summaries and graphs were examined to identify patterns and highlight areas that should be considered in Study B. For Study B, participants' responses were grouped thematically to allow for comparison and discussion between responses to general questions in the interview guide and the discussions arising from materials participants brought and those that we supplied. Due to the small sample size, we have endeavored to report the findings in detail and supported by direct quotations to maintain the individuality of experiences of the respondents, while reflecting upon the potential implications for practice.

4 Findings

4.1 Survey

Of the 38 participants who took part, 75% described themselves as completely blind, 10.2% as almost blind or severely sight impaired, 11.1% as partially sighted, and 2.8% as having no sight loss. Four individuals also declared another disability, such as deafness or Chronic Fatigue Syndrome. Most participants had learnt Braille when they were aged ten or under, with less than 25% of the participants learning Braille in adolescence or in adulthood. This may explain why 73.7% described their Braille proficiency as advanced (13) or very advanced (15). Only two participants declared their Braille proficiency as minimal or beginner and eight as intermediate. Most participants were either learning (3) or actively reading UEB (23), although 12 declared that they did not use UEB.

Which of these methods/technologies have you used for reading?

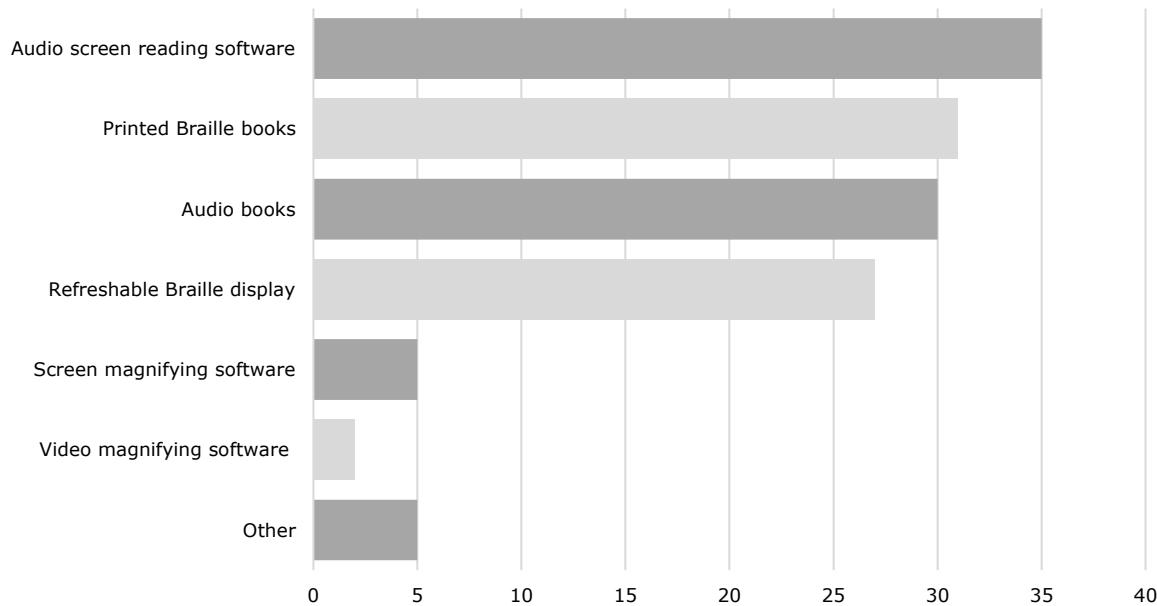


Figure 1: Technology use

As shown in Figure 1, most participants used audio screen reading software (e.g., JAWS) (35) and printed Braille books (31). Many participants also used audiobooks (30) and refreshable Braille displays (27). Screen (5) and video magnifying software (2) were used by comparatively few participants.

How often do you read for...?

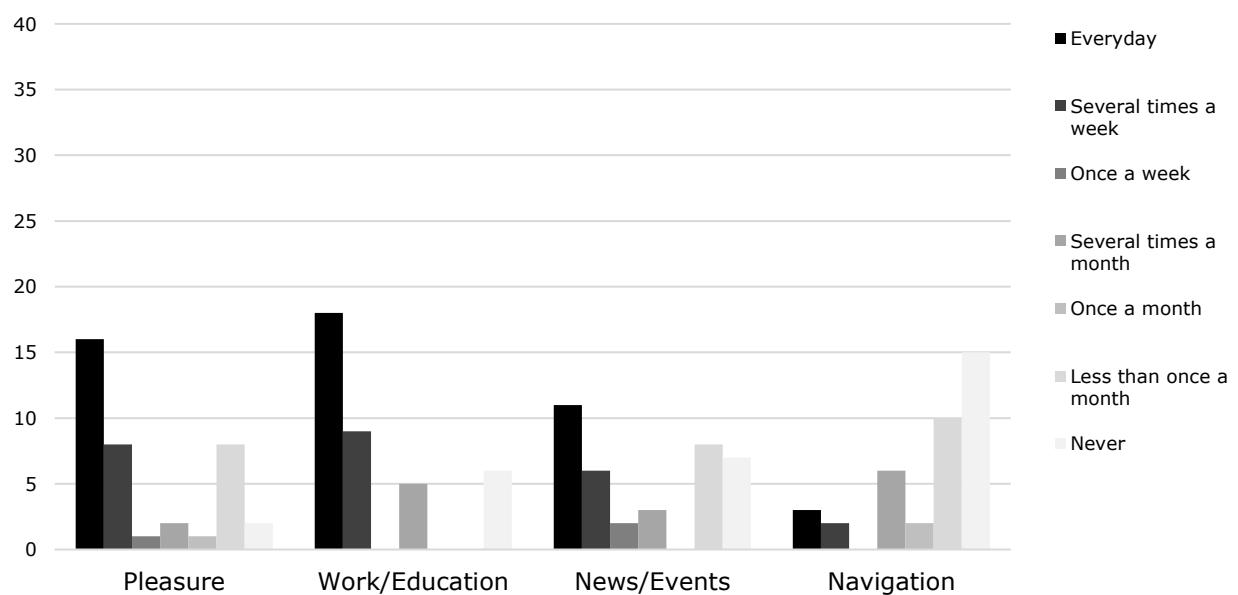


Figure 2: Reading behaviors

Figure 2 demonstrates that most participants regularly read for pleasure as well as for work or education, with only 35.9% (17) of the sample group indicating that they read to keep up with events and news on a regular basis. In contrast, very few participants (5) said that they regularly read for navigation.

Participants were asked to indicate the appropriateness of particular reading formats across different contexts of use. Technology choice varied substantially across different contexts of reading. Audiobooks were the preference for 15 users when reading literary texts (fiction/non-fiction), but only the preference of two users when reading a textbook or other educational source. As anticipated, audio screen readers were most popular when reading news articles and emails due to the appropriateness and practicality of a screen reader for computerized text. Refreshable Braille displays were deemed most appropriate for reading for education and when commuting, with a third of participants selecting refreshable displays as most suitable for reading educational texts. Despite being used by 31 out of 38 users, only nine participants selected printed Braille books as their preference for reading literary texts.

Participants were also asked about how Braille has influenced their quality of life. Their responses show that Braille was considered important for:

- Independence and social integration – e.g., 'It makes the difference between me being able to work, study and do other activities' (Referenced by 14 participants)
- Literacy – e.g., 'I would not be literate without having learned it' (Referenced by 12 participants)
- Retention – e.g., 'It is far easier to retain information from Braille than from any other medium' (Referenced by 1 participant).

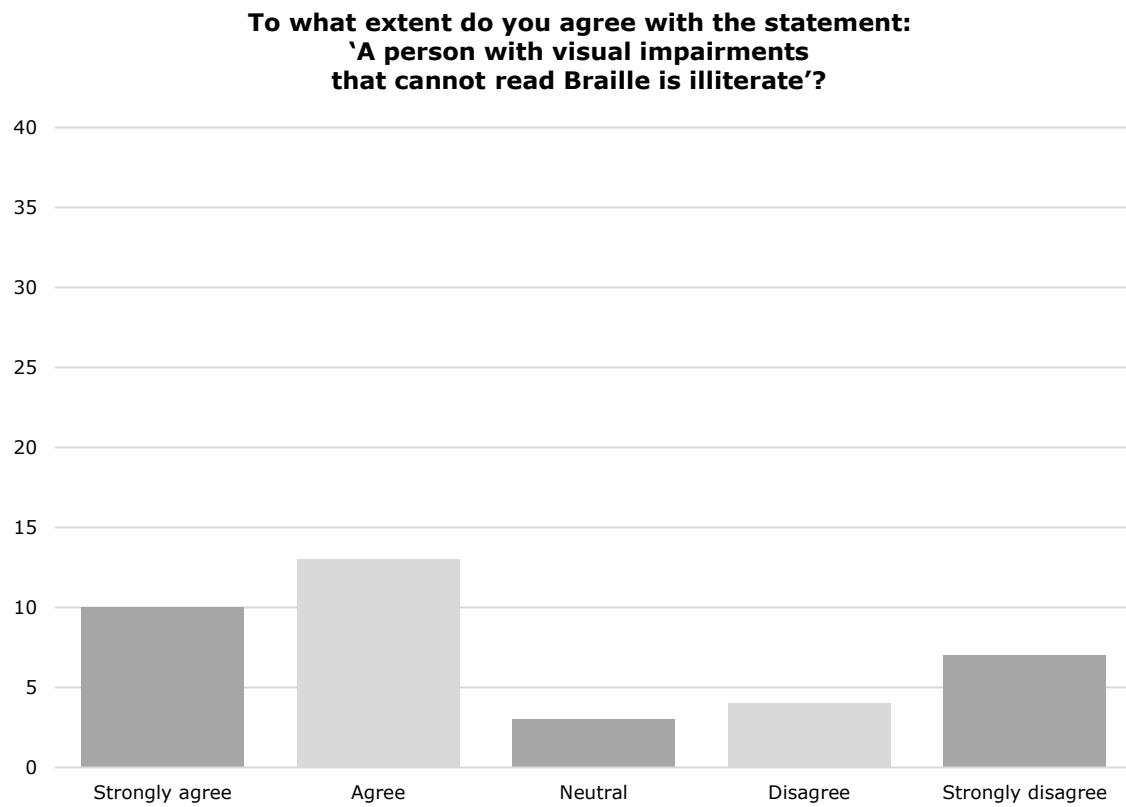


Figure 3: Opinions about literacy and Braille use

Judgments about the link between literacy and Braille use were further explored (Figure 3). Twenty-three either strongly agreed or agreed with the statement 'A person with visual impairments that cannot read Braille is illiterate,' whereas only eleven either disagreed or strongly disagreed, and three indicated a neutral response. Interestingly, the majority (90%) of participants who had described themselves as either advanced or very advanced Braille users agreed with this statement. In contrast, 60% of participants who described themselves as minimal, beginner, or intermediate Braillists disagreed or strongly disagreed with this statement. This marked difference in opinion across proficiency sub-groups could be explained by increased dependence on other technologies. Less proficient Braille users, for example, may be more dependent on audio and other technologies for reading, so accordingly may perceive Braille as less important for literacy. Advanced users, particularly participants who learnt Braille in childhood, seem to perceive Braille as more important for literacy. Participants also gave other reasons for their views. Participants who answered 'Neutral' explained that it depended 'crucially on the definition of literacy' or highlighted that the majority of information is not accessible to them in any medium: 'I certainly feel illiterate and knowing braille does not reduce this.' Differences between audio and Braille were clear in participants who agreed with the statement; 'Listening to audio is a passive process, whereas reading braille is active.' Some participants made an argument that Braille enables a higher level of understanding of the written form than audio; 'Only through Braille can we actually read, develop spelling, grammar... etc.' The relationship between literacy and different kinds of visual impairments was indicated by participants who disagreed with the statement: 'most people become visually impaired later in life and therefore are already fairly literate.' Some participants explained that 'technology is becoming more advanced' which enables other methods of reading such as 'audiobooks and iPhones,' so literacy can be gained without the reading of Braille. However, some participants did identify the disadvantage of listening to audio-only for skills such as spelling.

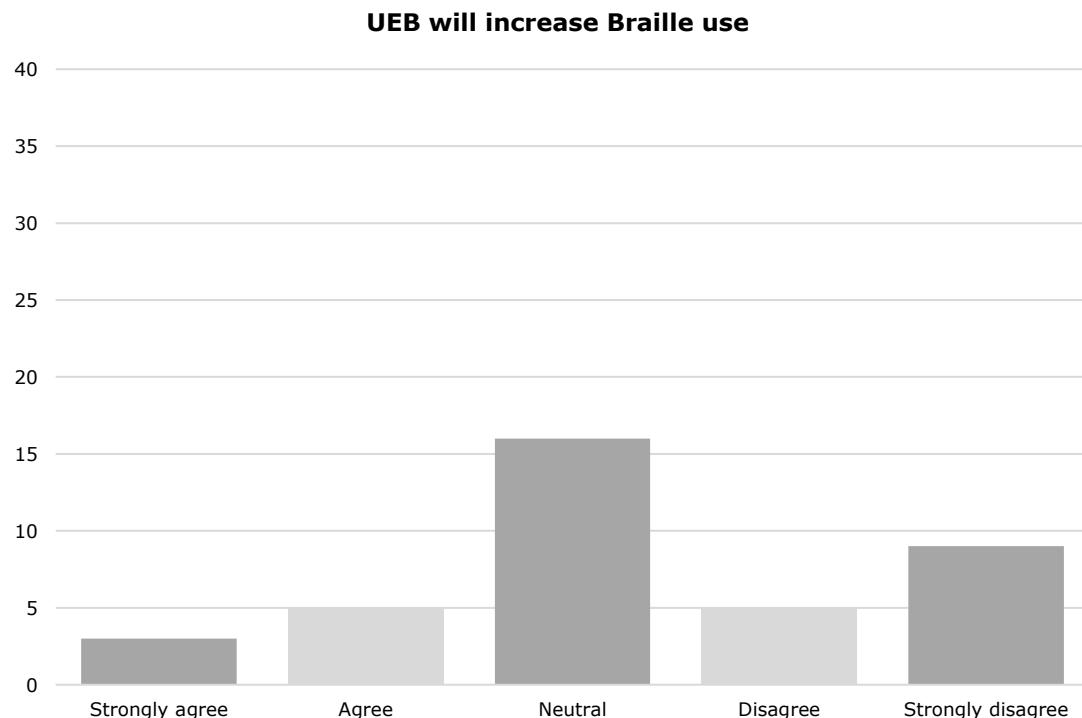


Figure 4: Opinions about the impact of UEB on Braille use

Figure 4 shows the perceived impact of UEB on Braille use: 36% anticipated that UEB would decrease use, 20% thought it would increase, with the rest of responders selecting 'Neutral.' This seemingly high proportion of neutrality may reflect the current transition period. For example, one participant suggested: 'While UEB and SEB coincide... you will need a handle on both systems'. Participants who agreed explained that UEB increases international accessibility; 'people learning or teaching Braille can do so... without having to question Braille codes.' Others explored the differences between Braille and print, explaining that 'capitalisation wasn't there before, and as print readers use capitals, it's only right that it should be used in Braille,' as well as the easier transcription process between print and Braille. UEB was also described as 'slightly more technology-friendly.'

However, participants who thought UEB would decrease Braille use explained that the transition period could mean that there is 'more than one code in use due to the existence of pre-UEB books'; new readers will need to learn both codes. Some said that the 'system has become more complicated for beginners to learn,' which could discourage the use of Braille, especially when there is a wide variety of available alternatives. For long-time Braille users, 'hostility' towards the new code seemed to stem from contractions from SEB being removed; 'ally, ation, ble, by, com, dd, o'clock, to and into' and the addition of 'emboldened or underlined text,' which they suggested slows their reading speed. One participant explained that 'the active hostility that some experienced Braille users show toward UEB will mean that they do not help to promote it and that Braille use will decrease.'

The future of Braille was explored, with multiple themes arising from responses. The trend of affordable refreshable displays was highlighted, which 'may offer a positive contribution to the continuation of Braille,' possibly allowing for increased access to Braille worldwide. Other mentioned themes included: the reduced quality of Braille teaching due to the integration of blind children into mainstream schools, the increase of modern technologies which pose a threat to Braille, as well as medical developments resulting in fewer children needing Braille.

4.2 Interviews

4.2.1 Reading technologies, behavior and preferences

Participants used reading technologies including audiobooks, large-print, and refreshable Braille displays. For example, Participant 2 used refreshable Braille displays and audiobooks for 'extra' reading. In contrast, Participant 5 used their Notetaker to make and read notes during meetings, rather than for more general, everyday purposes. Participant 1, on the other hand, did not have any portable Braille devices but did use a Focus (an 80-character Braille display) when using their computer. Participant 4, on the contrary, used the Kindle Paperwhite and the Kindle App on iPad for their main form of reading, unlike the other participants who mainly read using hard copy Braille. Participant 3 did not own or use any technologies specifically for reading, however, they did use a Braille display at work.

Participants read varying amounts for different reasons, including professional and educational use, reading novels for pleasure, studying Braille music, and more practical uses such as labelling. When asked about methods and technologies used for reading, many participants named hard-copy Braille first even though it was deemed a less appropriate method for reading in all contexts in Study A. In discussions of context of use, hard-copy Braille was considered the only suitable method of reading in church or in choir practice. Similarly, Participants 2 and 5 indicated that for active learning contexts where information needs to be 'digested,' hard copy Braille would be most appropriate due to increased retention.

Audio books were frequently mentioned for leisure reading. For example, Participant 1 noted that the ability to bookmark and skip allows for easy navigation. Participant 2 also explained that 'listening is a completely different activity to reading,' therefore was only suitable for passive tasks. Participant 4, who was the only participant with usable vision for reading,

preferred using Kindle with large print to access books for leisure. They also explained the drawbacks of the majority of large print: that the page has solely been enlarged, resulting in paper that is too impractical to read or store.

For reading for work or education purposes, refreshable Braille displays were used by four participants for reading and editing company documents. For Participant 3, reading is an integral part of their job, as they proof children's books and other written material on a daily basis. In the context of education, Participant 5 had used the RNIB transcription service for producing Braille course books. They noted that Braille provides indications of changes in typographic styling (such as italics to indicate changes in tone or emphasis), and in textbooks, these visual cues could be important to contextualize the text. Despite using both hard copy and paper Braille for course reading, they explained how reading paper can easily allow you to reread areas you do not understand as well as being vital for tabular data as it can all appear on the page at the same time.

To access reading materials, many had used the RNIB library to borrow hard copy books. Using the Internet to access Kindle, Audible books, and articles was also popular. None of the participants had chosen to buy paper Braille books. All participants had specific reasons why they used different methods for different purposes and seemed happy with their routines. Overall, hard copy Braille was deemed to be more flexible and portable, being used during activities like choir practices and Bible readings, as well as for reading for pleasure. Online resources were considered more practical for disposable texts such as newspapers, as well as for material that needed repeated referencing due to the ability to scan through the text. However, many of the participants noted that 'it would be nice,' rather than necessary, if more of the material they were interested in was available in their preferred format, as requesting books in a specific format takes time.

4.2.2 The future of Braille

The imagined future of hard copy Braille was explored, with Participant 2 failing to see an economic future for it: 'The cost of producing paper Braille will become prohibitive'. Participant 5 explored how the increased affordability of Braille displays would allow for increased consumption of Braille through electronic devices. They felt that hard copy Braille would only be produced for bespoke purposes, which may lead to higher quality and more thoughtful production. Participant 4 felt Braille use in the UK would die out completely, due to the lack of promotion in schools and poor quality and lack of standardization of Braille signs. A recurring theme was the integration of blind children into mainstream schools following the UK Equality Act, which participants compared to their own school experience. For many of the participants, learning Braille had been a compulsory part of the curriculum. This is no longer the case. Roe et al. (2014) explore the associated considerations for inclusive education more fully than we can do within this paper.

4.2.3 Materials brought by participants

Refreshable Braille displays were brought by three participants. These included displays that can be plugged into a computer (e.g., the Focus) and others which can be used with a USB stick to read stored documents without the need for a computer (e.g., the Notetaker).

The majority of books brought had been produced by either the RNIB or ClearVision. The quality and professionalism of the Braille print were remarked on by multiple participants. All participants' books, excluding ClearVision titles, used paper Braille which allows for double-sided pages. This significantly reduces the volumes required, which positively impacts the reading experience.

Participants were asked to bring an example of material that they deemed easy to read and asked to explain their choices. Despite bringing different materials, the quality of print production and binding were the most frequently raised themes that impacted the ease of

reading. Other reasons noted included format, genre, materiality as well as navigational and editorial features.

Interestingly, wire spiral binding was used in three of the five chosen examples. As Participant 3 noted, this kind of binding is helpful because it allows the book to lie completely flat.

However, they also stated that too many pages in a book could cause the binding to become undone, although this was not the case for any of the examples brought.

Both hard back and soft back books were among the examples. Participants seemed to agree that hardback books helped reduce the flexibility of the Braille pages, making the Braille easier to read. However, softback literature, common in magazines such as *VocalEyes* brought by Participant 1, allowed for the document to be folded back on itself. This means that less space was required when reading when compared to a hardback, aiding its portability. However, Participants 1 and 2 both commented that the curvature of the pages can make reading more difficult, clearly showing that both hard and soft back publications can have benefits and limitations in different contexts of reading.

Brought materials ranged in format from almost square to A4 in size. Most participants did not express a strong format preference, saying that the size did not affect the readability.

Participant 5 stated a preference for squarer books, as A4 has smaller line lengths resulting in an increased number of volumes. Participant 5 explained that contents pages, page numbers, and running heads are vital for navigation. A good quality cover page, detailing how many volumes there are as well as other editorial information was also important. These were seen as 'quite a luxury' when present in Braille books. Participant 5 also commented on labelling on covers. On one example, the label lies on the left of the cover, running from bottom to top of the book. This meant that books on a shelf could be easily identified while flicking through, without the need for taking it off the shelf.

ClearVision titles were brought by both Participants 3 and 4, who had similar reasons for bringing these to show. ClearVision books are published print titles, which have clear plastic Braille sheets overlaid onto each printed sheet. This adds to ease of reading and inclusivity, as a partially sighted parent can read with a sighted child or vice versa, as the images can be seen through the plastic. This approach was deemed cheaper to produce by participants as it uses existing printed copies.

Responses surrounding difficult to read material were more concerned with the content than in those that were easy to read. Two participants did not bring examples. Participant 2 explained that Braille is only difficult to read with old and worn books, most commonly in library books. Participant 3 referred to the content of the books themselves, explaining they owned nothing that was difficult to read as they learnt Braille at the age of 7. However, they explained that they found books produced in UEB harder to read as it slows their reading speed, but are becoming more used to the new code.

Participant 1 explored how the materiality and production quality of a book hindered readability, bringing a thermoformed statistics book made by the Student's Braille Library. Thermoformed Braille uses plastic heated under pressure, which can be used to create copies from a paper master copy. The main drawback of this method is that Braille can only be produced on one side, essentially doubling the number of volumes required. The book felt less professional to the participant, which could be explained by the smaller organization manufacturing the book, as well as the cheaper production method used. Participant 1 also explained that the dots are much sharper than paper dots, deeming it unsuitable for continuous reading. They also mentioned that the plastic binding used could lead to tearing of the pages with continued use.

Participant 4 instead explored how UEB has impacted the ease of reading, bringing a sample of UEB produced by the RNIB. Participant 4 used vision to read the Braille dots and suggested that the paper used made the dots harder to read, with the dots being too soft. The main difficulty for them was the UEB code, unfamiliar to them.

Participant 5 brought *VocalEyes*, a directory of audio described events such as theatre and arts. Interestingly, this example was brought by Participant 1 for an example of something easy to read, although their comments mainly regarded the content and genre which were of

interest. Participant 5 remarked on the label design, binding, and lack of navigational cues and clear hierarchy as reasons why this particular document was difficult to read. They explained how the contents page was omitted, and as the magazine was split into events by region, how it was difficult to find the desired information. The lack of running heads also added to this problem; the reader had to use clues from the body text to ascertain their location. Heading treatment was also deemed to be inadequate because they are not centered, making their treatment seem more like a paragraph.

4.2.4 Pre-provided materials

Braille packaging

Participants were shown four examples of Braille on packaging. Participants were asked to read the Braille on each example and explain what the products were. Participants considered most of the packaging examples hard to read, particularly for the cardboard tissue box and biscuit packaging because it was very soft. Three participants also mistook the shower gel for a toilet cleaner, which led to a discussion about the labelling of harmful products¹ and those with similar packaging (e.g., ready meals and tinned food) as opposed to products that may be recognizable from their tactile form (e.g., frozen chips). Only one of the participants felt that Braille should be a requirement on all packaging, while the other four queried the economic feasibility of such a requirement. Participant 1, for example, suggested that Large Print could benefit a greater proportion of people with visual impairments. In contrast, Participant 4 stated that having Braille on all packaging would show people who do not use it the everyday value of Braille. However, Participant 4 suggested that supermarkets have produced quantity over quality, and that the priority should be refining the Braille that is already there.

Participants were asked about what sort of information should be on Braille packaging. All agreed that a brief description of what the product is, as shown on three out of four examples, was a must. Other things included basic cooking instructions, allergy information, and use-by dates. Participant 2 stated that 'whatever is available in print should be available in Braille' but remarked on the impracticality of this due to the amount of space Braille requires. However, they suggested that the missing information should be available online with easy access. Participant 5 commented that if companies were expected to put a vast amount of information in Braille, they simply would not do anything at all and that some information is better than nothing. They also highlighted the standardization that would be required to ensure Braille appears in the same location on the same product, across different brands. They questioned where the best place for Braille is, noting that parts of the packaging would be disposed of immediately.

Grade 1 children's book

The award-winning children's book shown to participants was Menena Cottin's *The Black Book of Colours* published by Walker Books Ltd (2009). The book had Braille on each verso page with corresponding printed text, as well as raised tactile images on each recto page. Unlike the vast majority of paper Braille, the dots were not embossed; instead, they seemed to have been applied over the printed page with some sort of plastic.

However, participants' interactions with the book and their comments suggest that they found this very hard to read. Three participants struggled to initially locate the Braille, looking on the

¹ Braille on medicinal packaging has been an EU standard since 2010 (Royal Blind, 2011), however, the quality of Braille on cardboard seems very variable, and seemingly faint for some participants.

recto page rather than the verso page. Once located, all participants described the Braille as 'faint,' deeming it almost illegible. The Braille dots could also be felt through the recto page, which made it difficult to discern where the Braille was actually located. None of the participants could discern what tactile images were showing. Participant 3 explained some context is always needed, while Participant 1 stated that the surface was barely raised so they could only make out 'several blobs'. Participant 5 stated they felt the Braille was never designed to be read, and that is was a 'design gimmick.' The issue of line spacing also emerged: several of the participants thought this was too wide and that the Braille did not seem to follow any sort of standard.

When asked how easy it was to read aloud, Participant 1 said they were 'fighting the faintness of Braille.' Participant 2 explained that reading aloud, even with a good quality Braille book, is difficult, as it is hard to read ahead. Participants were asked their preferred method to read aloud to a child. Despite the lack of quality of this specific book, all participants preferred a physical book, in either Braille or Large Print. Participant 5 explained how they would feel 'rude' reading in any other way, as using headphones would distract from the reading experience, as well as making their presence unnecessary as a child could listen to the audio themselves.

UEB magazines

Participants were shown two Braille magazines: *Upbeat* and *Aphra*. Participants were asked to read aloud part of a magazine of their choosing, which could be done notably faster and with ease compared to the children's book, even while being set in UEB. Despite being staple bound, the magazines seemed to lie flat, which may have aided the ease of reading.

The preferred reading method for magazine content was discussed with participants. Participants 2 and 3 both indicated that hard copy Braille was better for continuous reading, whereas, Participants 1 and 5 said they would prefer using a screen reader. Participant 1 explained they would listen with audio alongside reading with their Focus because audio allowed them to navigate the content easily. They also stated that with paper Braille it is not easy to flick through until a section catches the eye. Participant 5 had a similar opinion, opting to allow JAWS to read it for convenience, using a refreshable display to examine how specific words are spelt.

Participants were asked if they would ever buy a paper magazine. Participants 2 and 3 did, with Participant 2 opting for paper so as to 'not be stuck on a computer all the time.'

Participant 1 explained that they would not buy many now, as you do not need to keep them, so paper is no longer needed. Participant 5, who said they would not buy a paper Braille magazine, made the argument that hard copy is not the right format for this sort of information. They explained that as Braille takes so long to produce, and the information in magazines is only current for a short amount of time, they cannot see it being useful or relevant.

The interviews highlighted variability and inconsistency of quality and legibility in hard copy Braille, particularly when printed on cardboard. It became apparent that large Braille presses produced work that was considerably higher in quality, and that binding had a big influence on ease of reading, with wire spiral binding showing the biggest positives. Staple binding was used for cheaper and disposable products, but the quality of this type of binding varied, with not all artefacts being able to lie flat.

5 Discussion and conclusion

The findings from both studies highlight how particular reading methods and technologies have a place in different contexts of reading. Similar to D'Andrea's study (2012), it became apparent that users' preferences diverged depending on the context of reading. Study A showed how participants ranked technology such as audiobooks (the most popular for leisure

reading), audio screen readers and refreshable Braille displays as most appropriate for specific contexts, with displays being suitable for reading while commuting, while screen readers were best for online resources. Nevertheless, participants in Study B also highlighted the importance of paper Braille, especially for: continuous reading, information that needed to be digested, children's books, and hobbies such as choir practice.

Technology use was high, with audio screen reading software being the most used reading method and the dominant preference for accessing online information. However, this does not mean that Braille use has decreased or has been replaced. The increase of affordable refreshable Braille displays is apparent in participants' preferences for reading educational texts and reading while commuting. Recent releases of displays such as the Orbit 20 similarly show an on-going demand for Braille. This finding is perhaps unsurprising given its practicality in comparison to the bulkiness of paper Braille. Participants' responses suggest that hard copy Braille may be preferred for continuous, literary reading because most refreshable displays only provide a few lines of Braille. However, with the development of multi-lined Braille displays such as the 9-lined Canute 360, Braille displays may become increasingly optimized for continuous reading, which could reduce the demand for paper Braille. Similar arguments have been set out by Tobin and Hill (2015).

The Study A responses indicate that Braille's potential in everyday wayfinding contexts may be underutilized and that more consistent quality, location, and availability of cues for people with visual impairments could be useful. These findings are also supported by Schölvink et al.'s (2017) study into 'research priorities of people with visual impairments.' In addition to research into technological improvements, their findings highlight a need for further consideration of how 'navigation, orientation, and accessibility of public spaces' influences mobility and orientation, and in turn, independence and social integration for people with visual impairments. Similarly, the responses in Study B suggest that areas such as book production and packaging merit further research. For example, studies evaluating the legibility and quality of Braille materials across a wider variety of products, and establishing ways of enabling people with visual impairments to easily look up product information online in a retail context, could help inform guidelines for inclusive packaging.

Braille's perceived importance spanned more than allowing users to read; allowing individuals to feel part of wider society, to gain literacy skills, which allow for personal expression, as well as being able to learn new languages, read music, and do other activities which would not be possible without it. Technological alternatives are presenting new possibilities, but it would seem that Braille still has a prominent role in enabling people with visual impairments to read, write, express themselves, and be part of wider society.

Against these findings and the current context of on-going technological change, it seems important for designers to consider the varied ways people with visual impairments may choose to engage with information and how their choices may relate to particular genres, reading contexts, and reading purposes. Collaborating with people from the blind and partially sighted community can help ensure suitability and more accessible design practices. In particular, in Braille production, whereas Braille can be legible by sight, it may not be legible by touch, so working together with expert users is paramount. In addition, it is essential to push the boundaries of design by moving beyond the assumption that new technologies might provide accessible alternatives. Considering how different technologies and materialities enable different reading experiences and how these might be more or less appropriate for particular design projects for readers with different kinds of visual impairments, is vital for inclusive design practice.

Acknowledgements

The research was carried out following review and approval from the University Research Ethics Committee. We thank all the Braillist members who kindly participated in this research project.

References

Braille Works (2016). *Braille Literacy Statistics and How They Relate to Equality*. Online at: <https://brailleworks.com/braille-literacy-statistics/> (Accessed 8 April 2019)

Braillists (2018). *Discussion Forum*. Online at: <http://braillists.org/forum/>

Candido, J. P. (2008) *Visual impairment in a visual medium: Perspectives of online learners with visual impairments*. PhD, Drexel University.

Cryer, H., Home, S. & Morley Wilkins, S. (2013), Unified English Braille in the United Kingdom: Part 1/2 – Examination by literary Braille users, Braille teachers, and transcribers, *The British Journal of Visual Impairment*, 31(3) pp. 228–247.

D'Andrea, F. M. (2018). Update on Unified English Braille Implementation in the United States. *Journal of Visual Impairment & Blindness*, 112(4), pp. 425–429.

D'Andrea, F. M. (2012). Preferences and Practices Among Students Who Read Braille and Use Assistive Technology. *Journal of Visual Impairment & Blindness*, 106(10), pp. 585–596.

Emerson, R. W., Holbrook, M. C., & D'Andrea, F. M. (2009). Acquisition of Literacy Skills by Young Children who are Blind: Results from the ABC Braille Study. *Journal of Visual Impairment & Blindness*, 103(10), pp. 610–624.

Engelhart, K (2012). *The importance of Braille literacy*. Online at: <https://freespeechdebate.com/case/the-importance-of-braille-literacy/> (Accessed 23 March 2019).

Farrow, K.R. (2015) Using a Group Approach to Motivate Adults to Learn Braille Using a Group Approach to Motivate Adults to Learn Braille, *Journal of Visual Impairment & Blindness*, 109(4): 318–321.

Ferrell, K.A., Mason, L., Young, J. and Cooney, J. (2006) 'Forty Years of Literacy Research in Blindness and Visual Impairment.' National Center on Low-Incidence Disabilities Technical Report. Accessed online: <http://www.pathstoliteracy.org/sites/pathstoliteracy.perkinsdev1.org/files/uploaded-files/Literacy%20Meta-Analysis%20Technical%20Report.pdf> (26 June 2019).

Graves, A. (2018) Braille Literacy Statistics Research Study: History and Politics of the 'Braille Reader Statistic', *Journal of Visual Impairment & Blindness*. 112 (3), pp. 328-331.

IONOS (2018). Screen readers: enabling the blind to work on computers Online at: <https://www.ionos.co.uk/digitalguide/websites/web-development/screenreader/> (Accessed 15 July 2019)

Papadimitriou, V and Argyropoulos, V (2017) The effect of hand movements on braille reading accuracy, *International Journal of Educational Research*. 88, pp. 43–50

Papastergiou, A. and Pappas, V (2019) A comparison of sighted and visually impaired children's text comprehension. *Research in Developmental Disabilities*. 85, pp. 8–19.

RNIB (2018) *Modern day Braille*. Online at: <https://www.rnib.org.uk/braille-and-moon---tactile-codes-braille-past-present-and-future/modern-day-braille> (Accessed 16 March 2019)

Roe J., Rogers, S., Donaldson, M, Gordon, C. and Meager, N. (2014) 'Teaching Literacy through Braille in Mainstream Settings whilst Promoting Inclusion: Reflections on Our Practice.' *International Journal of Disability, Development and Education*, 61:2, pp. 165-177.

Royal Blind (2018a). *Benefits of Braille*. Online at: <https://www.royalblind.org/national-braille-week/about-braille/benefits-of-braille> (Accessed 8 April 2019)

Royal Blind (2018b) *Braille Facts*. Online at: <https://www.royalblind.org/national-braille-week/about-braille/braille-facts> (Accessed 28 May 2018)

Royal Blind (2011). *Braille labels on pharmaceuticals*. Online at:
<https://www.royalblind.org/blog/national-braille-week/braille-labels-on-pharmaceuticals>
(Accessed 23 March 2018)

Ryles, R. (1996). The impact of braille reading skills on employment, income, education, and reading habits. *Journal of Visual Impairment & Blindness*, 90, pp. 219–26.

Ryles, R. (2000). Braille as a predictor of success. In J. M. Dixon (Ed.), *Braille into the next millennium* Washington, DC: National Library Service for the Blind and Physically Handicapped, and Friends of Libraries for Blind and Physically Handicapped Individuals in North America. pp. 463–491.

Schroeder, F. K. (1996). Perceptions of Braille usage by legally blind adults. *Journal of Visual Impairment & Blindness*, 90(3) , pp. 210–218.

Tobin, M.J. & Hill, E.W. (2015) Is literacy for blind people under threat? Does braille have a future? *The British Journal of Visual Impairment*, 33(3), pp. 239–250.

Verma, P; Singh, R. & Singh, A (2012). A Framework for the Next Generation Screen Readers for Visually Impaired. *International Journal of Computer Applications*. 47(10), pp. 31–38