Towards A Braille Radio Service

Research in the Rockies: Braille Research Summit

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Introduction

First of all, our thanks for the invitation to present on a new initiative at NPR we call Braille Radio.

Second, in full disclosure, and mindful of Kay's excellent overview and critique of the research projects to date in this field, we are newcomers to Braille, and only slightly more experienced in the field of applying inclusive technology to new media technologies. We use the word inclusive instead of accessible because we think that is more focused on the serving the underserved intent of the Public Broadcasting Act which established NPR and because, unfortunately accessibility is too frequently viewed as a collateral instead of mainstream activity in our society. We are not here to sell you on outcomes, merely to disclose the nature and status of this new initiative and to solicit your help as we move this project forward.

Captioned Braille is a three year field initiated project funded by the National Institute on Disability and Rehabilitation Research. Ellyn Sheffield, our cognitive research scientist from Towson University, and I serve as co-PI's on the project. Mike Eskenazi is our lead Technical Research Associate on the initial design criteria who has done the great work presented in this paper.

But in reality it is not our project. A short story if you will permit me. All things considered, I would not have expected this topic to surface as it did. Three years ago I was presenting at the TDI conference in San Mateo about NPR's Accessible Digital Radio Broadcast Services initiative and how we planned later in the year to conduct the first nationwide captioned radio broadcast on presidential election night. It was a small audience and I was personally debating the time away from work at the office to present to such a small group. Additionally, I was interrupted several times from someone in the back asking "What about Braille?" And each time I would answer: "I'm sorry I thought I was being clear: for the visually disabled we have a separate wing of this project that is working to upgrade analog radio reading services using digital radio multicast

technology to improve quality, choices, and to free up resources needed in the old days of analog FM subcarrier only delivery." Finally, at the end of my talk, a few people came forward, including one man with a guide dog and companion, and as he signed into his companion's hand, he said, "Hello my name is Bapin and I'm a technologist with the Helen Keller National Center and I want to know if you can make the radio captions available for the Deaf-Blind." Finally, the lightbulb turned on in my head on the concept of a Braille Radio Service! As Justice Holmes remarked "A man's mind once expanded by a new idea never returns to its original dimensions."

In the next five minutes we readily agreed to meet at the Helen Keller National Center at Sand Point and work together on the project that just started last October. I'm pleased to report that NFB is a partner with us on this project and I know that Mark and his capable electronic Braille technical virtuosos will help us produce the best "promising practices" possible in the 2 and ½ years ahead and beyond.

For Mark Riccobono, the concerns over the crisis in directions for Braille literacy and acceptance as mainstream media are very real, and I offer an observation. My doctorate is in Jurisprudence, not cognitive psychology as is the case of my esteemed co-PI Dr. Sheffield. So yes, I'm a lawyer, and lawyers are nothing if not advocates. I happen to teach media law and I implore my students every semester to use the facts to build their arguments and to constantly simplify them for the elevator conversation with a member of congress, or philanthropist, or venture capitalist or new boss ahead. In that regard, the simple fact published by the Perkins Institute that 70% of the blind who are employed are Braille literate and 70% of those who are not Braille literate are unemployed should immediately dispense with any misgivings over Braille relevance in the 21st century. As Kay indicated, evidence based practice is critical to our next directions, and that simple fact is an irrefutable testimonial for the utility and power of Braille literacy in an inclusive society.

The UN Convention on the Rights of Persons With Disabilities (CRPD) is added testimony that universal design and breaking down barriers to information and

communications technologies is a fundamental human right, now recognized by nearly 80% of the nations of the world. But make no mistake about it, our modest technology initiative on Captioned Braille is but one small part of the flint axe era digital technologies our civilization is embracing. All of us who use microwaves, cellphones, smart phones, tv set top box menus, and the computer to access and navigate the world's information know only too well how poorly these tools and technologies too often function in our newborn digital era hands. I was remarking to my son, the web-developer, that it has been remarked that alien observers on planet earth arriving today would reasonably believe that dogs and cats rule the planet since they are ministered to day and night by we humans. But in reality, I think it far more likely the aliens would attempt to communicate directly with our computers since we spend inordinate time each day ministering to the computers' apparent need to be used and tended to. How many of us spend more time communicating with our computers than with the humans in our lives?

We have a long way to go as is apparent by the abject frustration of the Deaf and Hard of Hearing community with the disruption of reliable captions that was a hard won success after decades of work and development as the new digital tv service went fully into effect just one year ago. The mop up work on restoring those captions through a vast array of incompatible cable head end technologies continues and has caused untold thousands of hours of lost time for the D/HH communities to report, track down, and dog to a conclusion. It is an unfortunate commentary on our ability to manage the state of the art for inclusive technologies throughout the HDTV revolution that started with the first demonstrations over a quarter century ago, in 1981.

As the saying goes the nice thing about standards is you can have so many of them. In that regard, I'll briefly mention that NPR has been successful through our work with the North American Broadcasters Association at advancing a standards document at the International Telecommunications Union in Geneva for all digital radio broadcast systems to provide a transmission protocol for the adoption of a caption radio channel in each new digital radio service. And we have proposed that these captioning

assignments include what's know as UTF-8 font and typeface support for all of the commonly used language character sets worldwide.

If you will permit me in marrying two quotes on information access and research that summarize much of my personal philosophy related to the accessibility work of NPR Labs.

As I tell my media law students it was Louis Brandeis who said in his famous concurring dissent in Whitney v. California "Mean feared witches and burnt women. It is the function of free speech to free men from the bondage of irrational fears." This is the essence of why we seek to expand the reach of audible and printed information from NPR – and indeed from all media organizations - into a useable realtime Braille format. On a good day at NPR this is exactly what we do best: demystify, educate and enlighten. And secondly, our favorite quote of Einstein's was "If we knew what we were doing it wouldn't be called research."

So I'm here to talk to you about our Braille Radio endeavor and to discuss some philosophical questions about the prospects of delivering live radio information over refreshable Braille displays.

We hit the ground running in this project by documenting the 17 currently marketed refreshable Braille displays, and seeking evaluation models most used by the Deaf Blind community from the manufacturers. Secondly, we conducted a preliminary assessment on the problems of keeping up with live radio programs. This is of special importance for the dissemination of life-saving shelter-in-place and evacuation information during emergencies such as tornados, wildfires or incidents such as Katrina and 9-11.

What we discovered is that the pace of live radio, especially our hourly newscasts, is nearly impossible to convert to captions faithfully on a real time basis, and would be nearly impossible to absorb via electronic braillers. This tells us something we

presumed would be true: buffering capability will be imperative for such a service. And we mean not just the buffering that is inherent in most refreshable braillers, but also within the interface of the caption radio receiver itself to control the rate of porting the captions to the external Braille displays. You'll note we are talking here about using existing external Braille displays since the costs and availability of displays for integration into the radios themselves would be completely prohibitive. No one would pay $2500 for a Braille radio. But using an existing brailler with a compatible digital radio costing $199 or less should be achievable within a few years.

NPR's accessibility efforts to date

All of telecommunications are migrating to digital transmissions, and radio broadcasting, the original wireless mass medium, is no exception. Digital radio transmissions were first authorized on an interim basis by the FCC in 2002. Today there are over 2,000 AM and FM broadcasters in the United States operating in HD Radio. Digital transmission technologies include the ability to send much more than ones and zeros to signify music and speech. Thanks to multiplexing techniques inherent to all digital transmissions, virtually any information can be interleaved with the audio information itself.

The list of new digital radio applications demonstrated to date include artist and title text, traffic graphics, radio captions, electronic program guides, and digital radio reading services designed for copyright exempt access to today's books, newspapers and magazines. All of these can be transmitted on dedicated sub-channel or in overhead of the digital stream as *bonded metadata. Bonded metadata* is a term we use that signifies the added audio will survive subsequent recording and playback.

National Public Radio has been a pioneer in what is now known as "multicasting" for digital radio, which we launched through a series of *Tomorrow Radio Project* initiatives that led to FCC endorsement in 2005 of multicasting for use by all FM HD Radio stations in the United States. Among the early NPR Tomorrow Radio initiatives was the *Accessible Digital Radio Broadcasting Services* project, funded by the Department of Education through the National Institute on Disability Rehabilitation Research which

demonstrated digital radio reading services for use by the print disabled, and Captioned Radio technology which added captioning transmissions for use by the Deaf and Hard of Hearing.

This paper presents early design work towards the fulfillment of a Braille-enabled Live Captioned Radio Service.

Preliminary Braille Radio project objectives are to design a “plug and play” seamless interface via USB and Bluetooth technologies for inclusion in future HD Radios to support existing electronic Braille refreshable displays. Specialized treatment of emergency alerting and messaging for Deaf Blind users is a key element of the work since radio typically is seen as a first responder for disseminating life saving information during emergencies.

Our great research team at Towson, led by Dr. Sheffield has done preliminary assessment work, spearheaded by Mike Eskenazi, whose work to date is summarized below. You’ll note that while we feel obligated to investigate the idea of scaffolding strategies for Braille access to radio information we have not set policies for how to proceed. As typical, our first year of work proceeds with preliminary feasibility research on technology integration as well as cognition. And it must be noted that NPR has an inherent bias for verbatim transcripts.

To give you an example, when I first entered network radio at Mutual Broadcasting back in 1974 it was routine practice to use our editing skills to take out the “uhs” and “ahs” of the President’s remarks “because he’s the President of the United States – he ought to sound good,” is what he newsroom editors told me back then. But just ten years later when on assignment by NPR we were told we should be viewing the landing of the space shuttle at Edwards Air Force base through our own eyes on the salt flats, as opposed to at the press center on NASA provided video monitors (where everyone else was). To this day, we NEVER edit the President or anyone else being interviewed

because it's important to us that the public hear every subtle nuance in cadence and tone that we humans are experts at assessing.

Thus, the question of highly contracted Braille, or scaffolding and telegraphic techniques by omitting certain words governed by a algorithm is controversial to us, and we welcome your comments and suggestions.

It is clear, however, that emergency evacuation and shelter in place instructions are a priority that should overtake any buffering that is being applied for immediate transmission of such potentially life saving information. It is also possible that some scaffolding strategy of presenting the artist and title information from the program associated data fields every time the unit is tuned in to a new broadcast are appropriate. And it could turn out that our contribution to a successful outcome is the non-trivial development and deployment of effective middleware to faithfully port the captioning from the radio to the Brailler via USB and Bluetooth connections, with needed controllable buffering speed and no telegraphic or scaffolding applied. However, it is an intriguing prospect that we feel obligated to assess further with the Helen Keller National Center and our colleagues at the National Federation of the Blind and other expert users.

Reading Speed

In developing a refreshable electronic Braille interface for the radio there are key consumer use questions including what content should be included, how the content should be presented, and when to present the information. It is well established that reading Braille is much slower than reading text visually. Knowlton and Wetzel (1996) attempted to increase reading speeds of Braille by implementing several different reading methods. In the oral reading category participants had to read out loud with no concern for comprehension, in the silent reading condition participants read silently for meaning and comprehension, participants had unlimited amount of time to read for comprehension in the study condition, and in the scanning condition participants were told what to look for before reading the passage. The results demonstrate that reading

rates were fastest for the scanning condition with an average of 202.9 words per minute. Participants were second fastest in the oral reading condition with an average of 135.9. The silent and studying conditions were the slowest, each with an average of approximately105 words per minute.

The results indicate that the reading rate of Braille depends on the task for which the person is reading. In the scanning condition the participants knew what type of material they were looking for so the reading rates were faster. They can skip over and pay less attention to unimportant information, which allows them to focus on and better understand the most relevant information. This information is important when deciding what to include in the refreshable Braille display for the radio. The results indicate that the display should include the most important information about the program so that it may be read quickly. A display like this coincides with Vygotsky's idea of scaffolding, which suggests that people will learn better when provided with the right information. Providing the reader with the right information in an approach consistent with scaffolding may allow for higher reading speeds with greater overall comprehension of the entire program.

The method in which the scaffolding summary is presented is also an important aspect. Since the refreshable brailler only has a limited amount of space it may be beneficial to have less or at least an abbreviated summary. One study compared sighted and blind participants in their ability to understand telegraphic speech (Martin & Sheffield, 1976). In this study the participants first had to rank all the words of a passage by how important they felt the words were to the meaning of the passage. They then eliminated 10%, 30%, and 50% of these words and measured comprehension at each level. Both groups had no significant impairments at the 10% and 30% telegraphic levels, but the sighted group had significant impairments at the 50% telegraphic level while the blind group did not. This study indicates another aspect that may be beneficial to include in the Braille summary. Since blind participants have no impairment at a 50% telegraphic level of text there should be no disadvantage to summarizing what they will be listening to telegraphically.

Braille Scaffolding and Text-Contraction Study

Reading Development

Reading can simply be defined as a process by which a sensory modality picks up information from the outside world and converts it into information that can be interpreted. In sighted reading the sensory modality is vision and the information from the outside world is light reflected from print. This information is furthered processed in the brain based on previous knowledge to create an intelligible message. In Braille reading the process only has one difference. The sensory modality is tactile and the information from the outside world is bumps from a 3X2 Braille matrix. Past this step the brain uses the same processes in sighted and Braille reading. However, it is important to understand the differences between sighted and Braille reading developmentally.

Preparation for reading of any type begins when children speak the first words at about 10-12 months, which is the same for both blind and sighted children. Following this development children begin to learn many words quickly in a fast-mapping stage. When a child is born blind this stages are not disrupted, but the relationship between the word and the referent are different. A sighted child has the ability of using our main sense, vision, to see and understand what an object is. They still use the other senses but usually to a lesser degree. For example a sighted child will be able to see an apple as a red, round, and sweet, fruit. However, a blind child does not have the ability to know what red is, or to perceive roundness in the same way that a sighted child can. A blind child must rely on all other senses to understand what this object is. They may describe an apple as a smooth, round, and sweet fruit. From a cognitive-developmental standpoint it is important to compare these two types of reading in terms of a reading model to understand the differences.

There are two types of models of reading: text-based and reader-based. In a text based model the focus is on bottom up processing based on isolated units such as letters or words. In contrast, a reader-based model uses top down processing in a constructivist approach. In this approach meaning is built based on schemata which are knowledge

structures about the relationship of concepts or objects. When readers are faced with new texts they use previously known schemata to draw meaning. Both bottom up and top down processes are important in different stages of reading so no single text-based or reader-based model alone works well. Chall (1983) developed a six stage model integrating both cognitive processes to understand the development of reading.

Stage zero is the first stage of reading development according to Chall (1983). This stage lasts from birth until school age. This whole stage involves gaining insight into the nature of words and speech. Sighted children may become familiar with many repeated signs or logos that they see without actually being able to read them. Encouragement from adults to become actively involved in reading is very important in this stage. Children will develop sensory awareness that will prepare them for future reading. Blind children are at a disadvantage in this stage since relationships between their sensory modalities and future reading may be unclear. Children must deliberately make connections between hearing, touching, tasting, and smelling to develop concepts of what words may represent. It is most important in this stage for parents to support richly detailed descriptions of objects and to provide a lot of verbal feedback. Also, in this stage sighted children are exposed to graphemes that they will use in the future to read, but blind children must deliberately expose themselves to Braille. Blind children should be exposed to tactile sensitivity training to build their knowledge for structures that will later be important in reading.

In stage one children begin to build their reading skills with formal training. They learn what sounds these previously arbitrary graphemes represent and what sounds combinations of graphemes represent. They also learn rules for irregular combinations and varying types of sounds. Most important in this stage is bottom up processing where the majority of attention is directed at the medium rather than the meaning. Braille reading is similar in this stage since blind children will develop relationships based on tactile representations and sounds. This stage may take longer since blind children are not previously exposed to Braille matrices. Braille readers also have more symbols to learn than sighted readers because Braille includes a contracted

component. Whether the child learns contracted Braille at this age or not the same steps are taken when the child actually does learn contracted Braille. Once the connections are made between the grapheme or the matrix and the same process is undergone by both types of readers. As they become more practiced the use of phonetics decreasing time is required in decoding words.

Children continue to learn phonetic patterns in stage two, but reading becomes more complex. They begin to see words as the whole rather than letter by letter, and children begin to break away from phonetic decoding. To become more automatic children are dependent on familiar words and phonetic patterns. Practice texts are still intended only for bottom up processing and should have nothing to do with gaining new knowledge. In Braille reading children can break away from phonetic decoding by becoming proficient with contracted Braille, which creates new matrices to represent more than one common combination of letters. Braille readers will encounter a disadvantage as compared to sighted readers in this stage. The perceptual span, or amount of information gained in one eye fixation, for sighted readers is about 10-20 characters. This allows a sighted reader to process multiple words at the same time in a single glance. Braille readers do not have this advantage and still need to move their fingers over one letter at a time. Some Braille readers are able to process multiple characters in parallel, but still cannot process an entire word at once. Cognitive demands are clearly greater for Braille readers and are illustrated through a couple techniques that inefficient readers use. Scrubbing is a term used to describe when a blind reader moves their finger back and forth over a letter. This is done because the reader cannot automatically recognize the letter. Another technique is backtracking, which is when the reader will go back to the beginning of the word to remember the original letters. This is associated with inadequate integration of information.

Stage three marks a shift in the development where focus is shifted from reading to gaining knowledge from reading. Children must first attain an automatic level of reading before progressing to this stage. Texts in this stage should not be complex, but should express ideas simply through one point of view. There should be some degree of

overlap and should include knowledge gaps that are large enough to be filled in with the child's previous knowledge. The new information in this stage is also at an appropriate level so that the child can integrate it successfully into their existing knowledge base. There is no reason to believe that blind and sighted children perform differently at this stage. A necessary prerequisite for both groups is sufficient life experiences and previous knowledge to interpret and create new knowledge. If these conditions are met then both groups will perform equally.

Stage four involves more complex learning of new knowledge including abstract cognitive representations from multiple points of view. Readers will integrate and add more depth to information that they learned in stage three. The only disadvantage that Braille readers encounter in this stage is the ability to read at the same pace as their sighted counterparts. Finally, in stage five readers have achieved the most mature stage in reading development. Expert readers can now use analysis, judgment, and synthesis to determine what is important to read, integrate new knowledge, and create new abstract ideas. Readers in this stage can read selectively and determine where to spend their cognitive resources based on well developed schemata.

Current Study

One goal of the initial project is to increase Braille reading speed without affect reading comprehension. The two main methods of achieving this goal will be through scaffolding and telegraphic speech. Scaffolding has been proven to be an effective method of increasing reading comprehension by providing an appropriate framework of information for the reader. This framework provides the reader with relevant information for what the person is about to read. When providing pre-reading information certain concepts will be activated in the brain, which will enhance the meaning and understandability when the person reads the actual text. It only takes a few sentences of scaffolding to activate the reader's mind to the appropriate context for the text. This study will test several different types of scaffolding to see which works the best. The first type of scaffolding is the traditional definition of scaffolding, which provides a short summary before reading and also some reminder information half way through the text. Another

variable that will be included in this study is abbreviated scaffolding, which only provides a short summary in the beginning. Including this variable will indicate if the second bit of reminder information is necessary. Finally a control condition will be presented, which will only include Program Associated Data (PAD) such as title, topic, and author.

Another variable that will be used to increase reading speed while not decreasing reading comprehension is telegraphic speech. Telegraphic speech involves removing words from sentences that are not important and do not add to the meaning of the sentence. Previous studies have shown that blind people are better at reading telegraphically than sighted people (Martin & Sheffield, 1976). Blind people had no deficits in comprehension up to the 50% level, however sighted people could only read at the 30% level with no comprehension deficits. Another study compared blind reading rates and comprehension at 20% and 40% telegraphic levels (Martin & Bassin, 1977). Reading rates decreased at 40% telegraphic speech, but comprehension stayed the same at both. The authors think that unfamiliarity with telegraphic speech may have caused the participants to read more slowly in order to make sense of the sentences with missing words.

This study also used two different types of telegraphic deletion schemas – the subjective method and the computerized frequency method. In the subjective method a preliminary study must be conducted with participants in order to figure out which words to delete. The participants must rank all the words of a sentence from least important to most important. The researcher then deletes the desired percentage of least important words from each sentence. In the computerized frequency method a computer program counts each type of words and how frequently each type of word occurs. The computer then creates a cumulative frequency table and systematically deletes words to the desired percentage of deletion.

Although both methods work well in psychological research there are practical problems with both of them. For the subjective method this process simply takes too long. A whole study must be done prior to even creating the telegraphic speech. Using this

method would not work in the radio industry since there is no time to go through such a long process when captioning programs. The computerized frequency method is much more efficient, however it has some technical problems. Since the program uses word frequency as a criterion for deletion many content words often get deleted. For example, if a program was about a car it is likely that the word car would be used frequently. When using the computerized method the word car would be deleted sometimes, which would create some confusing sentences. It is important to create a third method, which is a consistent list of rules of what types of words can always be removed from a sentence, without affecting meaning.

This study will remove articles, conjunctions, demonstratives, adjectives of quantity but not specific numbers, colloquial phrases, interjections, auxiliary verbs, possessives after the noun or pronoun has already been introduced, to in front of infinitives, and the universal you. When using this method about 20% of words are deleted. This is consistent with Martin & Bassin (1977) who found that reading speed and comprehension are not affected at the 20% telegraphic level.

NPR and the Helen Keller National Center are excited to be working on extending the nascent Captioned Radio service to Braille users. NPR has received international support for adopting standards that will work with all of the digital radio systems in use worldwide at the International Telecommunications Union. This development is critical for achieving broad manufacturing support, which is critical for fastest time to market and lowest manufacturing costs via largest economies of scale. We look forward to updating interested Braille researchers on the status of the project as the work continues and welcome any and all comments, suggestions and critiques. Our progress can be followed at www.nprlabs.org/research/accessibleradio.php.

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