A Comparative Study of Braille as a Tactile Orthography with the Auditory Orthography OVAL to Teach Reading to Preliterate, English as an Additional Language, Adult Learners Who Have Visual Disabilities

by

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The above committee determined that the thesis is acceptable in form and content and that a satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate during an oral examination. A signed copy of the Certificate of Approval is available from the School of Graduate and Postdoctoral Studies.

ABSTRACT

The purpose of this study was to investigate the affordances of the tactile orthography of braille in comparison with the newly developed auditory orthography of OVAL for teaching reading to preliterate, English as an Additional Language, adult learners who have visual disabilities. Seven adults who have visual disabilities, who learned braille after the typical reading development stage, that is, after the age of 10, and who are learning English as an Additional Language (EAL) joined the study from six different countries. The mixed-methods research assessed OVAL audeme retention after a period of training, surveyed and interviewed the participants on their attitude and perspectives towards both orthographies, and included observations by a certified braille and EAL instructor. Results showed a 71.29% average level of accuracy for OVAL audeme retention among the seven participants. For two participants, a comparison between OVAL audeme and braille letter retention yielded the following results: 100% for OVAL and 44.50% for braille. Survey and interview responses showed participants holding mixed views on the potential in OVAL. From the certified braille and EAL instructor perspective, both OVAL and braille meet the identified criteria and considerations of beginner reader programs for preliterate, EAL adults who have visual disabilities, although OVAL as an auditory orthography holds the potential to reduce at least some barriers and challenges inherent in a tactile orthography.

Keywords: orthography; literacy; braille; English as an Additional Language; auditory orthography

AUTHOR'S DECLARATION

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Michelle Strutzenberger

STATEMENT OF CONTRIBUTIONS

I hereby certify that I am the sole author of this thesis and that no part of this thesis has been published or submitted for publication. I have used standard referencing practices to acknowledge ideas, research techniques, or other materials that belong to others.

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Glossary

Term	Definition
audeme	The term audeme refers to the representation of a letter of the alphabet as a specialized sound as in the OVAL system.
braille	The term braille refers to the system of raised dots that represent the alphabet. In this paper, the first letter of the word braille will not be capitalized, other than when referring to Louis Braille, in keeping with the practice of the community that primarily uses braille.
EAL	English as an Additional Language
L2	A person's second language
OVAL	The term OVAL refers to the system of specialized sounds that represent the alphabet. In this paper, the word will be presented in full capital letters, in keeping with the practice of the OVAL developers and researchers.
people who have visual disabilities	In this paper, the phrase people who have visual disabilities will be used to refer to people who have varying degrees of visual impairment, including total blindness.
preliterate	The term preliterate in this paper refers to people who did not learn to read and write at the typical development stage

1. Introduction

1.1 Overview

While the traditional definition of literacy has been expanded over the past five decades to include more than the ability to read and write by processing symbols, the acknowledgement of literacy as a fundamental human right has remained strong. International conventions from the 1965 World Conference of Ministers on the Eradication of Illiteracy to the 2015 Incheon Declaration have urged the importance of literacy for holistic wellbeing and have committed to improving literacy rates worldwide (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2021). Literacy by these conventions has been acknowledged as a "means for development and not just an end in itself" (UNESCO, 2021, para. 11) as well as a key contributor to the "liberation" of people (UNESCO, 2021, para. 9).

This study is intended to add to the discourse on the experiences of people who have visual disabilities in achieving literacy. An estimated 2.2 billion people have a visual impairment, while 39 million people are blind globally (World Health Organization [WHO], 2019). For the purposes of this study, the term "people who have visual disabilities" will be used, encompassing people who with a range of visual impairments, including total blindness. For more than 200 years, literacy for people who have visual disabilities has been primarily enabled through knowledge of a code called braille. As a system of raised dots that is decoded by touch, braille provides literacy as defined in what might be considered the traditional sense, that is, reading and writing by processing symbols. Similar to the discussion on what exactly constitutes literacy in the broader population, views are mixed on whether knowledge of braille is a valuable standard of literacy for people who have visual disabilities (Al-Said, 2010). While these discussions are critical for the purpose of exploring how best to support human thriving within the context of

literacy, it must be acknowledged that reading and writing as defined by processing symbols still has a place in society. While that place may be fairly and wisely relegated to a subsection within a much larger sphere of what it means to be literate, it is still important. While some research on the prevalence of braille literacy suggests it has declined significantly over the past six decades (American Printing House for the Blind, 2016), a recent systematic literature review proposes that insufficient data on braille literacy rates over time exist and, therefore, it is not possible to know the extent of the decline (Sheffield et al., 2022). Sheffield et al. (2022) add that not knowing the exact number of braille readers, does not imply that "braille is unimportant or less important now than in the past" as it remains the "only reading and writing system that allows independent access to information and personal communication for people who are blind without the use of electronics or intermediaries" (p. 22). Educational studies show that academic instruction is significantly influential in braille literacy development (Guerrero, 2017), followed by students' personal determination, motivation, and initiative (Guerrero, 2017). Access to braille resources is also a necessary element of success (Guerreiro, 2013). It has been proposed that inadequate teacher preparation (Amato, 2000), lack of resources (Guerreiro, 2013) and lack of student interest and motivation (Guerreiro, 2013) have erected barriers to extending braille literacy. In 2020-2022, the global COVID-19 pandemic intensified some of these barriers, in particular access to braille materials and training in the use of braille materials (American Foundation for the Blind [AFB], 2022; Rosenblum et al., 2020). While audio haptics (technologically-produced sound and motion) now allow people who have visual disabilities to write/type on smartphones and computers, the expanded options for reading by decoding consist mostly of utilizing equipment and technology that presents braille in digital form. Barriers to accessing this technology remain. Addressing these barriers is one important step in advancing

braille literacy. In addition, consideration must be given to alternative systems for reading by decoding by people who have visual disabilities.

The literacy development of people who have visual disabilities must continue to be attended to in the same way that the literacy development of the sighted continues to be a priority. In its 2019 report on vision, the World Health Organization's recommendations include the following: "Raising awareness of the societal obligation to fulfil the rights of individuals with vision impairment and blindness that cannot be treated, to participate in society on an equal basis with others" (World Health Organization, p. 170). It should be considered a matter of social justice to both continue to evolve existing literacy tools, as is being done with braille, and also test new literacy tools. Given the tremendous advances in technology in general, there is no reason for these evolutions and innovations not to be undertaken.

An auditory orthography has been developed and tested by a team from the Hebrew University of Jerusalem. The team, which has undertaken two studies on the orthography, one on sighted, blindfolded, literate adults, and one on blind, literate adults, has proposed that the auditory orthography, known as OVAL, might prove to be a low-cost, accessible, easy-to-learn tool for enabling reading by people who have visual disabilities (Arbel et al., 2020). A study of the OVAL system with preliterate, English as an Additional Language (EAL) adults who have visual disabilities will advance the field of knowledge on systems that enable the literacy of people who have visual disabilities. The focus on preliterate EAL students who also have visual disabilities addresses the real-life complexity of meeting literacy needs. Not only are these participants learning a new language, but they did not learn to read and write at the typical development stage, and they are learning a new code. The current study will shed light on

whether people who have visual disabilities have any reason not to equitably benefit from the tremendous leaps in technological innovation today's world is experiencing.

1.2 Gaps

Other than those conducted on OVAL, no studies on strictly auditory orthographies for people who have visual disabilities are available. The two studies conducted on OVAL engage literate individuals who are learning the code in their first language (Arbel et al., 2020; Arbel et al., 2022). The two studies are also purely quantitative as they focus on the assessment of OVAL knowledge retention after training (Arbel et al., 2020; Arbel et al., 2022). The current study differs from the first two as it considers adults who are preliterate, meaning they did not learn to read and write at the typical development stage. This study also adds the complexity of training participants in OVAL in a language other than their first. If OVAL truly is as easy and fast to learn as initial studies show, what are the results for people who are preliterate and learning it in a second, third or fourth language? Finally, the current study is both quantitative and qualitative as it includes both the assessment of OVAL audeme retention and the attitudes and perspectives of both the learners and the instructor.

1.3 Research Goal

The current study investigates OVAL as an auditory orthography as compared to braille as a tactile orthography for learning to read by preliterate EAL adults who have visual disabilities. Specifically, the goal of the research was to assess the retention of OVAL audemes after a period of training, as well as identify participant attitudes and perspectives on the use of OVAL and braille for learning to read. Modifications to the researcher's original goal of comparing braille and OVAL letter retention rates among illiterate individuals had to be made due to challenges with recruiting participants with the noted characteristics in close proximity to the researcher.

1.4 Positionality Statement

I acknowledge that my positionality influenced my choice to undertake this research. My professional experience with the challenges of teaching literacy to preliterate EAL adults who have visual disabilities online during the pandemic fostered my strong interest in exploring alternative reading-by-decoding options for people who have visual disabilities. Inquiries I received from supporters of people who have visual disabilities in other countries on how to teach them braille given a lack of access to materials also provided motivation. As a certified braillist, I continue to teach braille and value its importance as the primary reading-by-decoding system for people who have visual disabilities. That said, I conducted my research with the strong intent to generate objective results on the affordances of OVAL as compared to braille. The findings of this study speak for themselves in this regard.

2. Literature Review

2.1 Overview

To provide context for the aforementioned research, this literature review addresses the following themes: a consideration of an expanded definition of literacy beyond processing symbols, including within the context of teaching English as an Additional Language; the benefits of reading; braille as the primary reading system for people with visual disabilities; alternative reading systems for people with visual disabilities; and, finally, the potential in reading by sound for people with visual disabilities. The limitations in previous research on reading by sound and a new auditory orthography in particular will be addressed in conclusion.

2.2 Literacy

2.2.1 An Expanded Definition of Literacy

The definition of literacy has widened considerably from its original focus on decoding symbols in the form of text-based orthographies. The argument for this expansion tends to be rooted in a belief that the language requirements and challenges in current workplaces, civic life, and the private realm have radically changed in large part due to computer technology but also cultural shifts (Deane, 2004; Sang, 2017; Cazden et al., 1996). As Sang (2017) exemplifies strikingly: "A Chinese customer reads a commercial advertisement presented in Japanese, an American listens to a Spanish song, and a Korean student watches the presidential debate between Trump and Hillary on YouTube" (p. 19). Sang offers this picture in part as an argument for the need to expand the definition of literacy. "Literacy practices are no longer restricted to reading and writing printed and written texts in one official and standard form but include multiple modes of representation in diverse cultural contexts and in various languages that are important in people's lives," he writes (2017, p. 19). Computer technology enables communication that encompasses

much more than processing text, and, for that reason, as well as the seismic cultural changes occurring in our world, literacy must include the ability to navigate that communication. This is the essence of Sang and other's reasoning for the need to shift to an expanded definition of literacy (Deane, 2004; Sang, 2017; Cazden et al., 1996).

An expanded definition, by necessity, is more ambiguous as it seeks to encompass a broader set of skills. However, several entwined themes emerge. An expanded definition of literacy:

1. includes the ability to recognize, interpret, assimilate, and appreciate ideas (Al-said, 2010; Sang, 2017).
2. allows for a variety of formats beyond just text for these ideas to be displayed (Al-said, 2010; Sang, 2017).
3. puts emphasis on literacy taking shape differently for different people depending on their goals, dreams, and context (Program for the International Assessment of Adult Competencies [PIACC], 2022).

Firstly, the expanded definition of literacy includes the ability to recognize, interpret, assimilate, and appreciate ideas (Al-said, 2010; Sang, 2017). The PIACC (2022) offers a different but related collection of verbs to describe literacy: "understanding, evaluating, using, and engaging with [ideas]" (para. 1). The emphasis is on the ability to interact with ideas. That interaction can take one of the following four forms: constructing meaning (recognizing, understanding); judging (interpreting, evaluating) ideas; assimilating (using and engaging with) them; and appreciating the ideas.

Secondly, the expanded definition of literacy allows for a variety of ways for these ideas to be displayed. While the PIACC (2022) emphasizes that they come through written text, other theories make room for representation in other ways, such as digital forms, semiotics, and the

arts, to name a few (Sang, 2017; Towndrow & Pereira, 2018). Research on the implications of an expanded view of literacy for English as a Second Language learners proposes that "writing and speech are now to be considered equally alongside multiple modes and ensembles of meaning making including gesture, image, colour, movement, sound, gaze, etc" (Towndrow & Pereira, 2018, p. 190). While it is not new to include, for instance, gesture, as an important element of communication, what is new is the inclusion of gesture, along with colour, movement, and so forth, as elements of literacy. Digital storytelling offers a way to understand this view; with digital storytelling, one can include some or all of the aforementioned – colour, gesture, movement, etc. – in the representation of ideas (Towndrow & Pereira, 2018). Thus, literacy--not just communication--could be said to include the ability to interact with ideas whether they are represented in symbols such as printed text or in some computerized form such as digital storytelling.

Finally, an expanded view of literacy takes note of the individual and is careful to emphasize that literacy can take shape in different ways, depending on the individual's goals, dreams, and context (Sang, 2017; PIACC, 2022; Towndrow & Pereira, 2018). While this might seem like an obvious point, it could be considered to differ from the traditional definition of literacy (the ability to read and write by processing symbols). This point is especially relevant in the context of literacy education. Rather than conducting a simple assessment of one's ability to decode symbols, regardless of goals, dreams, or context, an expanded definition of literacy highlights that each person will be interacting with ideas for different purposes. As the PIACC (2022) notes, "Adults have a range of needs they must address, from basic survival to personal satisfaction and to professional and career development. Literacy is increasingly complicit in meeting those needs" (para. 10). While one adult's literacy needs may look like learning how to

navigate an online course that allows them to find a new job, another's literacy needs may relate to understanding medical documents in order to help their child through an illness. Again, this may seem like an obvious point; of course, literacy education must be adapted to individualized needs. The difference may be largely in the acknowledgement by educators in particular that literacy does include more than just processing symbols.

2.2.2. An Expanded Definition of Literacy Pedagogy

A broader view of literacy necessarily has an impact on the shape of education (Sang, 2017; Cazden et al., 1996). The New London Group is considered a frontrunner in the introduction to this broader view of literacy pedagogy (Cazden et al., 1996). Comprised of 10 educators from Australia, Great Britain, and the United States, the self-dubbed New London Group first met in 1994 to discuss the state of literacy pedagogy (Cazden et al., 1996). Out of that discussion emerged an approach to literacy pedagogy the group refers to as "multiliteracies" (Cazden et al., 1996). The group identified a need to shift from a stringent focus on traditional literacy pedagogy, which they define as "teaching and learning to read and write in page-bound, official, standard forms of the national language" (Cazden et al., 1996, p. 61). They (Cazden et al., 1996) offer the term "mere literacy" to represent a kind of literacy that they suggest remains "centered on language only,…a stable system based on rules such as mastering sound-letter correspondence" (p. 64). They propose that such a view of language will "characteristically translate into a more or less authoritarian kind of pedagogy" (Cazden et al., 1996, pg. 64). In contrast to mere literacy, the New London Group proposes that a pedagogy of multiliteracies better meets the realities and needs generated through the evolution of both communication and culture (Cazden et al., 1996).

Similar to the definition of literacy, the characteristics of a broader literacy pedagogy are also

necessarily more ambiguous. The emphasis is on cultivating the conditions for students to take ownership of their literacy development in relation to their own contexts, including past experiences and future goals (Sang, 2017; Cazden et al., 1996). The New London Group notes that "To be relevant, learning processes need to recruit, rather than attempt to ignore and erase, the different subjectivities – interests, intentions, commitments, and purposes – students bring to learning," (Cazden et al., 1996, p. 72). In keeping with this approach, the one providing instruction does not take the traditional stance of downloading information to the student, such as information on sound-letter correspondence. Instead, the educator adopts the related and overlapping roles of facilitating, appreciating, stimulating, and enabling (Sang, 2017; Cazden et al., 1996).

Firstly, the educator as facilitator within the context of literacy holds space for students to undertake a variety of literacy-related activities (Sang, 2017; Cazden et al., 1996). These activities include, but are not limited to, simply facilitating the "understanding of purposes and functions of the resources" (Sang, 2017, p. 19). They could also be as expansive as facilitating dialogues among diverse communities (Cazden et al., 1996). The key point is that the educator within the broadened sense of literacy pedagogy creates an open space for understanding and discourse.

Secondly, the educator stimulates within the context of a broadened definition of literacy pedagogy (Sang, 2017; Cazden et al., 1996). In particular, the educator stimulates students' metacognition (Sang, 2017). The New London Group (1996) offers a few suggestions for how an educator and education environment might do this, including "simulating work relations of collaboration, commitment, and creative involvement" (p. 72) as well as using the school as a "site for mass media access and learning" (p. 72). Again, the contrast is with the traditional

educator as a “fountain of knowledge” pouring into the students’ empty cups. Instead, the educator is setting up literacy learning situations relevant to the scenarios students are already encountering or will encounter in their “real lives.”

Thirdly, the educator takes on the role of appreciator, with a focus on appreciating the diversity of students’ backgrounds, experiences, contexts, and future visions (Sang, 2017; Cazden et al., 1996). As the New London Group (1996) points out, “The role of pedagogy is to develop an epistemology of pluralism that provides access without people having to erase or leave behind different subjectivities” (p. 72). In order to avoid the erasure of these subjectivities, there must be an appreciation of them.

Finally, the instructor as enabler in the best sense of the word creates the conditions for the students to generalize their “learned literacy knowledge in different contexts” (Sang, 2017, p. 19). The New London Group (1996) describes it this way: “With their students, teachers need to develop ways in which the students can demonstrate how they can design and carry out, in a reflective manner, new practices embedded in their own goals and values” (p. 87). The educator in the broadened view of literacy pedagogy creates a way for learners to move their meaningful knowledge learned to other contexts or cultural sites.

A careful consideration of the above roles shows that they are all similar and even overlap. Inherent in the role of a facilitator, for example, are the acts of stimulating, appreciating, and enabling. The same could be said of each of the other roles. The important point is that, within the realm of expanded literacy possibilities enabled by technological advancements and cultural changes, the role of a literacy educator also becomes much more expansive.

Given that the current study addresses learning to read in English as an Additional Language,

we must ask whether this expanded view also applies to English as an Additional Language pedagogy.

2.2.3 Literacy Education in English as an Additional Language

A review of the literature shows multiple recent studies considering multiliteracies as the framework for English as an Additional Language pedagogy (Mirhosseini & Azadeh Emadi, 2022; Burke & Hardware, 2015; Warren & Ward, 2019; Towndrow & Pereira, 2018; Hepple et al., 2014; Nelson, 2006; Eamer & Hughes, 2013). The studies overwhelmingly highlight the benefits of a multiliteracies framework in teaching English as an Additional Language, with three benefits noted: the benefit of building student agency (Warren & Ward, 2019; Towndrow & Pereira, 2018; Hepple et al., 2014; Eamer & Hughes, 2013); the benefit of providing an avenue for students to become meaning makers through the use of multi-modal content (Burke & Hardware, 2015; Nelson, 2006); the benefit of drawing on the culture and lived experiences of all students in the literacy learning environment (Burke & Hardware, 2015; Towndrow & Pereira, 2018). Firstly, studies show multiliteracies projects engaging students who are learning English as an Additional Language foster student agency (Warren & Ward, 2019; Towndrow & Pereira, 2018; Hepple et al., 2014; Eamer & Hughes, 2013). In one study, English as an Additional Language students were tasked with creating animated movies made with clay puppets, referred to as claymation, as a way to interpret a novel and adapt a movie (Hepple et al., 2014). In the case of the movie, the authors (2014) highlight that the claymation project was "notable for how the students exercised their agency—how they took ownership of the project, leading the different stages of production, negotiating choices in storyline and composition to achieve their particular version of the [theme]" (p. 225). This sense of agency likely arose in part because the students themselves identified the movie they wanted to adapt, and then were

given space to develop the adaptation on their own terms (Hepple et al., 2014). The modality, claymation in this case, in which they were working also most likely played a part in fostering this sense of agency (Burke & Hardware, 2015; Nelson, 2006). As Nelson (2006) states, "Multimodal communication offers a potential levelling effect, an alternative route whereby new understandings can be reached that are ultimately supportive of authorial expression in the L2" (p. 71). This point relates to the second benefit of enabling meaning making through the use of multimodal content (Burke & Hardware, 2015; Nelson, 2006). In another study, English as an Additional Language students created photostories representing their thoughts on a novel in relation to their own cultural understandings and practices (Burke & Hardware, 2015). The authors (2015) point out that "this photostory provided an avenue for students to become 'meaning-makers' (The New London Group, 1996, p. 76), hence, helping them to recreate and engage in the discourse of the text they were studying" (p. 154). As Towndrow and Pereira (2018) note, the multiliteracies framework affords English as an Additional Language learners a wider range of resources to use both in expressing their interpretation of texts and also in creating new meanings. "This would also allow them to critically frame, read and craft meanings that match their interests and identities more aptly," the authors go on to note (Towndrow & Pereira, 2018, p. 190). This point relates to the third benefit, which is drawing on the culture and lived experiences of all students in the literacy learning environment (Burke & Hardware, 2015; Towndrow & Pereira, 2018). As noted in the section above on multiliteracies in general, the multiliteracies pedagogy focuses on appreciating the diversity of students' backgrounds, experiences, contexts, and future visions (Sang, 2017; Cazden et al., 1996). This has significant relevance in the realm of English as an Additional Language pedagogy as well. In conclusion, recent studies are highly favourable towards multiliteracies as a framework for English as an

Additional Language pedagogy, but a few do note some challenges.

Several studies highlight a number of challenges around conducting assessments when using multiliteracies to teach English as an Additional Language (Mirhosseini & Azadeh Emadi, 2022; Burke & Hardware, 2015). National educational contexts can present such challenges, as noted in one study (Mirhosseini & Azadeh Emadi, 2022) conducted in Iran. The study suggests the challenges may be in part due to the historical context of the educational environment there, where "structured teaching and pre-specified learning activities have continued to be the norm for decades and clear-cut learning outcomes and test results continue to rule" (p. 84). The authors (2022) propose that part of the solution may be simply taking the time and effort to uproot long-held concepts. However, another study (Burke & Hardware, 2015) also points to the need for more research on how to assess new literacies, "so as to 'ensure that issues of assessment do not lead to [multiliteracies'] exclusion or marginalization in the curriculum' (Hammett, 2007, p. 350), especially in light of the emphasis on standardised testing and measurable forms of assessment" (p. 84). Burke & Hardware (2015) propose a bridge needs to be formed between conventional assessment in schools and a new way to conduct assessments for multimodal projects. "This may make multiliteracies projects more attractive to teachers since they will parallel their mandated tasks," they suggest (2015, p. 4). In sum, challenges around the assessment of multiliteracies activities do exist, but the overarching perspective on the multiliteracies framework for students in general and also English as an Additional Language students in particular is highly positive.

It is critical to start with an acknowledgement of this expanded view of literacy and literacy pedagogy, including within the context of learning and teaching English as an Additional Language (EAL), as my study focuses on reading by processing symbols. More specifically, my

study addresses learning to read by processing symbols in EAL as a person with visual disabilities. As an entrenched benchmark of achievement in society, underscored by even such widely venerated institutions as the United Nations, the traditional definition of literacy is increasingly viewed as a gate restricting possibility rather than a door to new worlds. Advocates of an expanded definition of literacy are saying that the digital era and other factors have opened a new door to what it can look like to be literate, and we must be careful against holding too tightly to the rusted, old gate of literacy as mere symbol processing. Yet even while the research supports an expanded definition of literacy, and there is certainly no reason to doubt the value in this broader perspective, this does not discount the right that all people hold to learn to read by processing symbols if they choose. The question is not whether mere literacy trumps multiliteracies, or vice versa, but rather that, even while widening the gate when defining literacy, it is important to acknowledge that the widened gate holds space for reading by processing symbols. As the next section shows, reading offers benefits, though the research is not always clear on whether this is relegated to reading by processing symbols.

2.3 Benefits of Reading

2.3.1 Results of Educational Research Studies

Even as an expanded definition of literacy is acknowledged, studies show that reading has benefits. My research is interested in the benefits of reading by processing symbols, that is reading as defined in the traditional sense, but the research does not make an explicit case for this. Instead, educational research studies tend to include other factors that suggest that it may not be reading by processing symbols alone that yields these benefits (Cunningham & Stanovich, 1998; Tien, 2015; Talani, 2012; Sullivan, 2015; Scott & Saaimon, 2016; Chang et al., 2021; Rizzolo et al., 2011; Bavishi et al., 2017). Some of these other factors include reading volume

(Cunningham & Stanovich,1998; Talani, 2012); reading for pleasure (Sullivan, 2015; Chang et al., 2021); reading for the purpose of destressing (Rizzolo et al., 2011); reading books (Bavishi et al., 2017); and attaining certain reading skills (Scott & Saaiman, 2016). Firstly, extensive reading or reading volume has been shown to increase vocabulary (Cunningham & Stanovich, 1998; Tien, 2015). Cunningham & Stanovich (1998) point to studies showing reading has cognitive consequences that cannot be found in simply listening to mainstream TV shows, taking part in conversations, or even direct teaching. An example of a consequence is increased vocabulary, they note. "Many researchers are convinced that reading volume, rather than oral language, is the prime contributor to differences in children's vocabularies" (Cunningham & Stanovich, 1998, p. 138). Cunningham and Stanovich (1998) also point to studies showing "those who read a lot will enhance their verbal intelligence" (p. 157). As their word choice reveals, reading "a lot" seems to have implications for vocabulary and verbal intelligence, but it is not necessarily the act of processing symbols that contributes to this benefit. In other words, it is possible that a person listening to someone else read "a lot" of text could reap the same results.

Secondly, a similar statement could be made of studies drawing attention to the benefits of reading for pleasure (Sullivan, 2015; Chang et al., 2021). One study (Sullivan, 2015), which followed the lives of everyone born in England, Scotland, and Wales, in a particular week in 1970, found that "those who read books often at age 10 and more than once a week at age 16 gained higher test results at age 16 than those who read less regularly. In other words, reading for pleasure was linked to greater intellectual progress, both for vocabulary, spelling, and mathematics" (p. 5). The study (Sullivan, 2015) noted that it "compared children from the same social backgrounds who had achieved similar cognitive tests at ages 5 and 10" (p. 5). Similarly, a study that followed Taiwanese adults over the age of 60 over the course of 14 years found that a

higher frequency of hobby reading, that is twice or more a week, was linked to a "reduced risk of decline in cognitive function over the long term" (Chang et al., 2021, p. 70). Again, the results do not clarify whether the reading activities necessarily involved decoding symbols, or if the same results could have been attained through listening to audio books.

Thirdly, a study (Rizzolo et al., 2011) on the combined effects of yoga, humor, and reading on stress also does not distinguish whether it might have been reading by processing symbols alone that generated the benefits the study identified. The study found that one 30-minute session of yoga, humor, and reading significantly decreased certain indicators of stress in the 22 participants, all health science students (Rizzolo et al., 2011). However, for the reading component, the study simply notes that the subjects read articles about historical events and innovative technology, adding that further studies are required to clarify why stress reduction was noted after the reading. "The students may have found the neutral reading material to be relaxing, thereby decreasing the sympathetic nervous system arousal and resulting in a reduction of stress," the study suggests (Rizzolo et al., 2011, p. 85). Notably, the study does not distinguish the system (print text versus audiocast, for example) the subjects used to read.

Fourthly, a study on the advantages of book reading over reading other types of material also does not explicitly state whether it is referring to reading by processing symbols alone, although one could surmise that is the case (Bavishi et al., 2017). Following 3,565 adults over the course of 12 years, the study concluded that, compared to non-book readers, book readers had a four-month survival advantage and a 20% reduction in risk of mortality (Bavishi et al., 2017). But, once again, the question can be posed, would the same results have been generated had the participants not been reading by processing symbols?

Finally, the same could be asked of a study of 479 post-secondary students learning English

as a Second Language in South Africa which found that the 96.1% believe that good reading skills will "improve their academic performance and make them better students" (Scott & Saaiman, 2016, p. 10). The students offered these opinions after participating in a reading program that required them to read and demonstrate an in-depth understanding of two prescribed novels (Scott & Saaiman, 2016). The reading program was intended to "change the reading attitudes of students by motivating and encouraging them to read, which could lead to the achievement of academic success" (Scott & Saaimon, 2016, p. 4).

Reading a lot, reading for pleasure, reading to destress, reading books, and attaining certain reading skills can offer benefits to the individual, these studies show, but is the act of decoding symbols a necessary factor in achieving these benefits? Or could these same benefits be achieved through, for instance, listening to a screen reader read out the text? The research is not clear.

Of note, a community in the U.K. has made reading aloud "a tool for social inclusion and cohesion, as well as a cure for the marginalisation and isolation caused by mental illness" (Seia & Mazzoleni, 2021). The Reader, a charity that organizes groups to come together to read aloud and discuss novels, short stories, and poems, reports based on feedback from participants the following impacts: people feel more connected to others; people experience improved wellbeing; people have a greater sense of purpose; people have a better relationship with literature (2022). In this case, one would have to deduce that reading aloud consists of decoding symbols, but one could also safely surmise that it is more the act of reading aloud in community rather than the act of decoding symbols that generates the impacts listed above.

In contrast, the results of some studies showing that writing skills improve due to reading and reading instruction (Graham et al., 2018) suggest, if not explicitly, that these studies define reading as processing symbols. A meta-analysis of 92 studies examining whether reading and

reading instruction improved the writing of students in preschool through Grade 12 reported 91% of studies reported that the interventions improved writing scores (Graham et al., 2018). With respect to reading, 15 studies in the meta-analysis showed an improvement in preschool and elementary students' spelling through reading words and longer text (Graham et al., 2018). This result would not have been possible if the students had not been reading by processing symbols, rather than, for instance, hearing text read aloud. With respect to reading instruction, 54 studies in the meta-analysis (2018) showed that "more time devoted to teaching reading resulted in stronger writing outcomes than less reading instruction did" (p. S40). Of these 54 studies, 42 examined either the impact of phonological awareness instruction or phonics instruction on writing, with the remaining 12 dealing with reading comprehension instruction (Graham et al., 2018). Like the reading results, one could conclude that the positive effects of reading instruction on writing (at least in the case of the 42 studies focused on phonological awareness and phonics instruction) necessarily define reading as processing symbols. In the case of reading instruction dealing with reading comprehension, it is possible that this could encompass reading "by listening" although the authors do not make this distinction. The majority of the studies, however, do indicate that reading and reading instruction have a positive impact on writing skills, and it is possible to deduce, based on the nature of the studies, that it is the decoding symbols aspect of reading that could be said to account for this outcome.

2.3.2 Results of Neuroscience Studies

If educational research tends to be less clear about linking the act of reading by processing symbols with certain positive cognitive outcomes, other than the aforementioned writing benefits, neuroscience studies, offer less cloudy proof that reading by decoding symbols does enhance at least one facet of the individual–the brain (Dehaene et al., 2015; Perfetti et al., 2001;

Castro-Caldas et al., 1999). Castro-Caldas et al. (1999) refer to a functional MRI (fMRI) study that found a change in brain activation through reading, as noted in the differences in some aspects of the brains of literate versus illiterate subjects, namely, as they describe it, “a thicker band” of certain fibers (p. 143). The authors propose that the “absence of a constant practice of reading and writing to stimulate this bi-hemispherical neural network, may result in poor development of the proper transcallosal connections in that specific region” (Castro-Caldas et al., 1999, p. 27). Castro-Caldas et al. (1999) define illiteracy as “the total absence of knowledge of graphemes and their phonemic value,” (p. 23). Dehaene et al. (2015) analyzed research considering the impact of literacy on the human brain by examining brain images of illiterate and literate people as well. Their research points to a clear link between literacy and three aspects of brain activity: early visual processing; the ventral visual pathway, and the phonological coding system (Dehaene et al., 2015). It is clear that the definition of literacy in these studies equates with reading by processing symbols. Firstly, when the authors refer to the impact of reading on early visual processing, they note that adults and children who have learned the alphabet show enhanced functional MRI (fMRI) activation in response to various visual stimuli, including letters, faces and pictures (Dehaene et al., 2015). The authors point to several benefits to behavioural tasks as a result, even outside the reading domain, including an improved “analytical strategy of attending to pictures” (p. 240). Secondly, their studies show that a part of the brain that has come to be dubbed the “visual word form area (VWFA)” is activated more in literate than illiterate individuals when they are presented with a script (letters or words) they have learned (Dehaene et al., 2015). The authors note that the responsivity of the VWFA to script is “clearly an outcome of literacy acquisition,” adding that “the VWFA responds more to a given script than to faces, objects or places only in people who have learned to read that script” (p.

235). Finally, these studies show increased brain activation in literate versus illiterate subjects when participating in a spoken word exercise, meaning that literacy appears to have a direct impact on the brain's ability related to speech processing (Dehaene et al., 2015). A potential ramification of this is that literate adults may have a much larger verbal memory than illiterate individuals, the authors note (Dehaene et al., 2015), adding, "This effect may partly reflect a benefit from spelling knowledge, which provides an additional code that supports memorization" (p. 240). Thus, neuroscience studies show a clear link between certain noted benefits and the likelihood that it is the act of reading by processing symbols that creates these. The same link is seen when the act of reading by processing symbols involves feeling the symbols with one's hands, as in the case of people who are blind or visually impaired.

Studies show that there is similar activation in the brain dubbed the "visual word form area" when congenitally blind adults learn to read with their hands, that is learn to read a system of raised dots known as braille (Sadato et al., 1996; Buchel et al., 1998; Reich et al., 2011;). The so-called visual word form area is located in the left ventral occipitotemporal cortex of the brain (vOTC). Studies show the vOTC of individuals who are blind "responds more when reading braille than when touching meaningless patterns" (Kim et al., 2017). Activation in the same area is also noted when people who are blind or visually impaired learn to recognize letter shapes using an auditory sensory substitution device, which use sound to convey information that is normally understood through vision (Striem-Amit et al., 2012). Thus, it could be said that the term "visual" word form area is not quite correct; rather, the studies that this site of the brain is "tuned to abstract shape information that can be conveyed by various modalities," (Dehaene et al. 2015, p. 237). The important point to note is that, similar to processing visual symbols, the act of reading by processing tactile or aural symbols, is shown to generate brain activity.

Even while the research indicates clear benefits of reading by processing symbols, there could be a question about the interest in proving these benefits for anyone, but given the context of this particular research, especially people who are blind or visually impaired. For the latter, it could be argued that the technological developments of the last few decades mean they no longer must learn to read by processing symbols in order to function in society. Today, the option of simply listening to text being read to them has been made ubiquitous through screen readers, voiceovers, and various apps, such as Seeing AI, which reads aloud printed material, such as a phone bills, as well as describes people and items one encounters. The argument that being able to read by symbols strengthens one's writing skills can also be made a nearly moot point given the voice-to-text options also now ubiquitous. In other words, it could seem that reading by processing symbols has become mostly unnecessary from a functional standpoint for people who are blind or visually impaired. While the aforementioned brain benefits may be a motivating factor for some, the more important point to be made is that people who are blind or visually impaired should have the option to read by processing symbols if they wish. Just as sighted children are not denied the right to education, including learning how to read, despite the technological advancements that might seem to make certain aspects of education less "necessary" today, people who are blind or visually impaired, must have the same opportunity to learn to read by processing symbols. If they then choose to simply listen to text and/or use the multitude of technological options available to them to meet their daily needs in ways other than by reading by decoding, they, of course, have that right as well. But the door to reading by decoding must always be wide open for them. This is a fundamental human right. For almost two centuries, that door has been kept open through a reading system developed by a teenager named Louis Braille in the 1800s. Today, we call that system braille.

2.4 Braille as the Path to Literacy for People with Visual Disabilities

2.4.1 Importance and Benefits of Braille

Braille is a tactile orthography consisting of a unique pattern of raised dots for each letter of the alphabet. Conceived of by Louis Braille in France, each braille letter appears as a cell of six dots. As Braille Works (2022) notes, cells of different configurations that consist of only six dots means that each finger can "encompass the entire cell unit with one impression and move rapidly from one cell to the next" (para. 10). Braille has come to be used in many languages around the world (Braille Works, 2022); some of these languages include Japanese, Chinese, Korean, and Spanish. Just recently a U.S. student helped to develop a Uyghur version of the braille alphabet (Kashgary, 2022). Braille has come to be accepted throughout the world "as the fundamental form of written communication for blind individuals," remaining for the most part just as Louis Braille invented it (Braille Works, 2022, para. 10).

Braille Works (2022), and other organizations supporting people who are blind, along with ongoing research highlight the benefits and importance of knowing and using braille (Canadian National Institute for the Blind [CNIB], 2022; Braille Literacy Canada, 2022; Farrow, 2015; Ryles, 2000; Schroeder, 1996). The organizations cite the opportunity that knowing braille affords for people who are blind or visually impaired to be aware of written conventions such as spelling, punctuation, and grammar (CNIB, 2022; Braille Literacy Canada, 2022). As CNIB states, "Audiobooks and technology that 'speak' a text through a voice synthesizer program don't give new readers the tools that they need to read and write for themselves" (para. 9). The organizations also highlight how braille gives individuals who are blind or visually impaired access to a wide range of reading materials such as recreational and educational reading, financial statements, restaurant menus, and more (Braille Works, 2022). The ability to read

braille even extends to opening opportunities to take part in certain hobbies and cultural enrichment as individuals can access music scores, hymnals, playing cards and board games coded with braille (Braille Works, 2022). In daily life, braille may be used to label clothes, medication, appliances, kitchen items and more (CNIB, 2022). Farrow (2015), Ryles (2000), and Schroeder (1996) cite evidence supporting the benefits of braille for increased employability, independence, confidence, and self-determination for people who are blind or visually impaired. Similarly, CNIB (2022) emphasizes that braille offers to people who are blind or visually impaired what printed text offers to people who are sighted – "intellectual freedom, personal security and equal opportunities when they grow up" (para. 6). Braille Literacy Canada (2022) states braille is "the key to literacy and independence" (para. 1). It has also been suggested that the ability to use braille is a "freedom of speech" issue; Englehart (2012) states that for those who use braille, "reading code is integral to their literacy, and by extension, their expressiveness" (para. 8). In fact, as Argyropoulos et al. (2019) note in their paper, "There is a strong belief, pervasive throughout the literature written by professionals in the field, that the denial of braille to children who need it leads to major educational disadvantage, and that auditory input alone cannot compensate for lack of braille" (p. 164). While the many benefits and importance of braille are acknowledged, research on the preferences and opinions of the blind or visually impaired with respect to braille offers insight into the lived experience of making braille a part of one's daily life.

2.4.2 Experiences and Preferences with Respect to Braille

While not discounting the benefits and importance of braille, people who are blind or visually impaired have varying responses and experiences with the practicality of using braille in their daily lives (Argyropoulos et al, 2019; Marshall & Moys, 2020; D'Andrea, 2012). A study of 75

students with visual impairments, aged 10-15 years, in Greece, found that while the majority of the students said they preferred to study through braille or large print, they tended to rely more on listening to text being read to them for their studies (Argyropoulos et al, 2019). The participants said they believed they achieved their best performance through listening to text being read to them, noting it was less tiring and time-consuming than reading braille or large print (Argyropoulos et al, 2019). The researcher suggests several factors created the conditions for the participants to respond in this way, namely the heavy class workload of the students and the fragmented training of braille instructors in assistive technology (Argyropoulos et al, 2019). Another study based on a survey of 38 U.K. residents who are blind or visually impaired discovered that users' preferences changed depending on the context of reading (Marshall & Moys, 2020). While the most used reading method was listening to an audio screen reader, participants did note they preferred refreshable braille displays (a piece of computer hardware that has refreshable braille cells on its surface) for reading educational texts and reading while commuting (Marshall & Moys, 2020). Participants also highlighted the importance of paper braille for certain activities, such as "information that needed to be digested," and "hobbies such as choir practice" (Marshall & Moys, 2020, p. 54). In sum, the participants used braille in some contexts, and not others, with listening to text being their primary method of reading overall. A study of 12 students in the U.S. between the ages of 16 and 22 who were enrolled in an academic school program, either high school or college, and who used braille as their primary medium, found that while the participants also acknowledged the importance of braille, they valued the "greater access to information they have compared to students who read braille in previous generations" (D'Andrea, 2012, p. 595). These participants also used paper braille, refreshable braille, and screen readers interchangeably. All the studies concluded that it is important that

people who are blind or visually impaired have options when it comes to accessing written content. D'Andrea (2012) focuses on education, noting that, "to allow students to take advantage of the choices available to efficiently complete school tasks, they must be proficient in multiple methods and tools for learning" (p. 595). However, the same point could be made about those who may not necessarily be in an educational context. There is no reason in today's technologically advanced society that people who are blind or visually impaired would not have at their disposal a variety of easy-to-use, accessible tools for reading, whether that is reading for educational purposes, recreation, socializing, work, or health. Before considering some of these tools, and one in particular, which is the focus of this paper, it is important to consider the factors shaping the use and prevalence of braille.

2.4.3 Factors Influencing the Use of Braille

Even as braille continues to be held up as the primary literacy tool for people who are blind or visually impaired, several factors are influencing its use worldwide, among these: the availability of qualified teachers (Argyropoulos et al, 2019; Kalra et al., 2009); its accessibility, a factor more pronounced in developing countries (Kalra, 2009; Saifullah, 2021) as well as during the pandemic (American Foundation for the Blind [AFB], 2022; Rosenblum et al., 2020); competition with other technological mediums for accessing text (Al-said, 2010; Tobin & Hill, 2015); and finally the challenges of learning braille, including as an adult (Martiniello et al., 2022; Martienello & Wittich, 2022). Firstly, the shortage of qualified teachers is cited as a key factor in the extremely low literacy rate – 3% - of the population of blind and visually impaired people in developing countries (Kalra et al., 2009). This finding correlates with my own experience in recruiting people who are blind or visually impaired for this study as several either live in or emigrated from what would be classed as developing countries. These participants

noted no programs or instructors were available to provide them schooling in braille as children. Even in the developed world, however, the shortage of trained professionals following consistent standards is noted as a barrier to more extensive braille use (Argyropoulos et al, 2019; Amato, 2000). As Argyropoulos and co-researchers note in their study (2019), "despite the fact that the students preferred to read and study through braille in the end because of the limited provision of braille education–including the usage of AT–through professionals and the corresponding educational system, they believed that the solution for their access would come only through the listening modality" (p. 164). Secondly, access to braille materials is identified as a barrier, notably in developing countries (Kalra et al., 2009; Saifullah, 2021). A study of 13 participants completing higher education in Bangladesh found that while they were knowledgeable of braille, "all of them agreed there is little to no study material available for their academic courses" (Saifullah, 2021, p. 410). However, access was also noted as a new problem during the pandemic throughout developed countries (American Foundation for the Blind [AFB], 2022; Rosenblum et al., 2020). Researcher L. Penny Rosenblum and a team from the American Foundation for the Blind surveyed more than 1,400 people across the U.S. and Canada shortly after the pandemic began. In their report, they examined the impact of COVID-19 on students, families and educators. With relation to braille, 32 of the 435 teachers of students with visual impairments (TVIs) surveyed indicated that due to COVID-19 they were no longer allowed to prepare braille materials for their students (Rosenblum et al., 2020). The report goes on to note that, "TVIs were also often unable to provide hard copy braille to their students because they did not have access to an embosser and/or braille translation software, were not allowed to take materials to students' homes, or their students lived at a distance from them (p. 85). "Braille provision and instruction in other tactile methods of learning, like the abacus, has been quite challenging," a professional

is quoted as saying in the report (p. 85). This experience lines up with my own as a instructor of several students who are blind and learning English as an Additional Language throughout the pandemic. While I received permission to mail them braille materials, the fact that they were just beginning to learn English compounded the challenge of teaching them to read the braille through the daily video-conferences we held. While in-person instruction would have allowed me to support the correct positioning of the paper, for instance, to even start reading, online, they did not understand English well enough to know left from right or up from down. Thirdly, the use of braille is influenced by competition from other technological options, particularly screen readers (Tobin & Hill, 2015; Schroeder, 1996). As Marshall and Moys (2020) note, braille can be time-consuming to read. A student might listen to an article numerous times and comprehend it in an hour, where it might take two hours to read the same material in braille (Al-Said, 2010). Fourthly, braille has been noted as potentially challenging to learn, particularly as an adult, and especially for those with reduced tactile sensitivity, which is integral to braille reading, although increased exposure and practice have been shown to help to mitigate these challenges (Martiniello et al., 2022; Martiniello & Wittich, 2022). While three of the above factors seem to have obvious if not challenging-to-implement solutions - increasing the number of qualified instructors, and increasing access to, as well as practice with, braille materials – it is less clear how to address the impact of the easy-to-learn, easy-to-use, virtually globally accessible screen reader and related audio tools. A number of options have been noted in the literature.

2.5 Alternatives to Braille and Braille Instruction

While some argue that reliance on screen readers and related audio tools is in fact not a problem with respect to literacy (Al-Said, 2010), others suggest changes are needed to how braille is learned, with other modalities included (Carey, 2016), while still others argue for a completely

new orthography to be made available for people who are blind or visually impaired (Arbel et al., 2020). In his study of four groups of stakeholders – university students, teachers, literacy specialists, and professionals, each of whom worked with or were themselves blind or visually impaired, Al-Said (2010) concluded that "it is evident that in literacy comprehension skills, auditory learning is not only possible, but also very efficient and effective" (p. 116). As part of his research, Al-Said conducted an experiment to determine if differences existed among three groups of individuals in their ability to process and recall information through their preferred way of processing text. The three groups consisted of individuals who were blind or visually impaired and either used braille or did not and individuals with sight who read visual print. Al-Said (2010) noted no differences "were found among three groups in recalling propositions in their preferred method of accessing print or when listening to text" (p. 115). These results along with a related qualitative study are used by Al-Said (2010), who identifies as a "blind person who does not read braille, but also as a scholar" (p.123) to "challenge the current definition of literacy, which is perceived by many policymakers and educators in the world of blindness and visual impairment, as well as in the world of the sighted, as the ability to read and write in print or in braille" (p.123). While Al-Said notes the importance of an expanded view of literacy for people who are blind or visually impaired, other researchers suggest it is possible to retain braille as a tool of literacy, but, similar to Al-Said's point, not exclusively so (Carey, 2016). In a speech titled, "The Survival of Braille is in the Balance," Carey (2016) highlights the importance of significantly reducing reliance on professionals to develop braille skills. "In our new, self-service world of online shopping and apps, it seems to me that the essential for braille is that it can be self-taught, ideally with a braille display in tandem with synthetic speech and modifiable print; but, in any case, self-taught. If we continue to rely on professionals to provide tuition, then it is

only a matter of time before braille dies" (Carey, 2016, p. 7). Argyropoulos and co-researchers (2019) agree with Carey's call for a multi-pronged approach to the literacy of people who are blind or visually impaired, noting that, "Future research should focus and investigate all potential cognitive processes that people with Vis [visual impairments] activate when using a multiple combination of means for their studies to comprehend a content" (p. 164). They suggest that a balance between aural and haptic reading "will activate their neural networks such as cognitive and motor control mechanisms helping them to develop literacy and communicative skills in a holistic way (Argyropoulos et al., 2019, p. 165). Considerable research has been conducted on aural-haptic and/or haptic options for people with visual disabilities (Al-Qudal et al., 2014; Arato et al., 2014; Norberg et al., 2014; Power & Jürgensen, 2009; Paneva et al., 2020). A review of the options around the accessible presentation of information for people with visual disabilities concludes that devices and applications which include a combination of aural and haptic output are more "readily acceptable by the user community" (Power & Jürgensen, 2009, p. 119). The review considers information such as text that people with visual disabilities need to access, as well as graphics, web pages, and other types of codes, such as math symbols. For the purpose of this research, we are interested in audio haptics specifically related to reading text.

Recent developments are expanding opportunities for people who have visual disabilities to comprehend and access the world around them in ways they never could before (Hofstetter et al., 2021), but in keeping with the goal of this particular research, this literature review is focused on developments that allow for reading text through decoding symbols. A pilot study has been conducted of a system to represent six-point braille characters using a mobile device with tactile feedback (Al-Qudah et al., 2014). The study notes that of three tested versions, one in particular yielded a high rate of character recognition. The study also highlights the low battery usage of

the mobile device that had the test application. Proposed follow-ups to the study include adding an audio feature, as well as a feature that allows the user to speed up or slow down the reading of the code (Al-Qudah et al, 2014). In another study, a deaf-blind person tested a technology based on a combination of braille and Morse code. The participant learned to read and write SMS messages on a smartphone by converting characters to vibrating braille dots and Morse words (Arato et al, 2014). While the applications seem to hold promise, further study is required. Use of these particular applications also depends on a knowledge of braille. Users must convert the haptics and/or audio haptics to braille and then to the characters or contractions (combinations of letters) represented by the braille. While this is not necessarily a disadvantage, it does have potential implications for reading speed. It may also pose a barrier for some, especially those who for various reasons, including reduced tactile sensitivity, struggle to learn the intricate code (Stevens et al., 1996).

Another system has been created that, while based on features of both braille and Morse code, does not require a knowledge of braille or tactile sensitivity to use it (Arbel et al., 2020; Arbel et al., 2022). The system allows people with visual disabilities to read by processing symbols aurally. While it does not include a haptic feature as yet, that may be a point of consideration for the developers in the future. The system is known as OVAL (Arbel at al., 2020; Arbel et al., 2022). The developers propose that OVAL may offer an alternative orthography for people with visual disabilities that is affordable, easily accessible, as well as easy and quick to master, including into adulthood (Arbel et al., 2020).

2.6 The Potential in Audio for Enabling Reading as a Literacy Skill

2.6.1 The Potential in Reading by Sound

Several studies point to the potential and benefits in decoding text through sound, as a possibly

faster, easier way of reading than through touch (Maier at al., 2004; Arbel et al., 2020; Sigalov et al., 2016; Horowitz, 2013). It has been noted that aural sensing is the fastest of all the senses, which has implications for reading training and speed (Horowitz, 2012). Auditory scientist Seth Horowitz (2013) highlights studies showing that while visual recognition requires about a quarter of a second to process information, a sound can be recognized in 0.05 seconds. "Studies have shown that conscious thought takes place at about the same rate as visual recognition, requiring a significant fraction of a second per event. But hearing is a quantitatively faster sense. While it might take you a full second to notice something out of the corner of your eye, turn your head toward it, recognize it and respond to it, the same reaction to a new or sudden sound happens at least 10 times as fast" (Horowitz, 2012, para. 4). In contrast, the tactile sense processes even slower than both sight and hearing (Horowitz, 2013). The team involved in the development and research on OVAL note, "It is known that the auditory system has a higher resolution in both time and frequency than that of the somatosensory receptors on the skin" (Arbel et al, 2020, p. 3). The above research refers to the processing speed of the senses in general, but what are the results when processing text through one of the senses – vision, hearing, or touch? While vision processes printed symbols and touch processes braille, to date, the only option for processing text by sound has been through Morse code. A neuroscience study compared reading speeds in Morse code versus reading print (Maier et al., 2004). The performance speeds were the same, with the study noting similar brain activation in reading Morse and reading print (Maier et al., 2004). The study confirmed that "reading Morse code retrieves meaning from simple auditory stimuli effortlessly, fast, and without awareness" (Maier et al, 2004, p. 187). There appear to be few, if any, studies comparing the speed of reading braille with reading Morse code. However, a study of 122 people who are blind and another 133 who are sighted, matched by age and education

level, found that when they took one of the most commonly used tests for reading in Spain, those reading in braille were significantly slower than those reading print, despite a similar comprehension level (Gonzalez-Garcia, 2017). The average reading speed in braille was 67 words read per minute, compared to 154 in print (Gonzalez-Garcia, 2017). The author notes the results are commensurate with the results of similar studies that have been conducted, that is, that reading in braille tends to be two to three times slower than reading in print (Gonzalez-Garcia, 2017). Considering then that reading via Morse code and reading via print show similar performance rates, while reading via braille is shown to be much slower, the research begins to make the case for an auditory orthography as a potentially faster, easier way to read by processing symbols. While, as noted above, there has been research on the use of some variation of Morse code combined with braille to allow for aural reading by processing symbols, OVAL has now undergone two significant research studies, with the results showing significant promise (Arbel et al., 2020; Arbel et al., 2022).

2.6.2 OVAL: A New Auditory Orthography

OVAL offers an alternative to braille and audio (i.e., screen readers) as the primary mediums for people who are blind to read. OVAL is an auditory-based alphabet, the characters of which are composed by combining features from braille and Morse code, although a knowledge of braille is not required in order to learn it. The OVAL characters have unique auditory spatio-temporal patterns termed audemes (Arbel et al., 2020). An initial study on 18 blindfolded, sighted, literate individuals highlights the potential in this system as an easy-to-learn, affordable alternative for enabling reading by the blind (Arbel et al., 2020). The study showed a 96.97% level of accuracy in identifying the 11 audemes after six hours of training on one of two versions of the system (Arbel et al., 2020). Another study by Arbel et al. (2022), currently under review for publication,

also identifies the potential in the system. Further testing such as that completed in my research add to our understanding of the potential in OVAL.

2.7 Limitations and Methodological Issues

There are at least four limitations in previous research focusing on auditory literacy options for people who are blind or visually impaired. Firstly, there are zero studies on strictly auditory orthographies for people with visual disabilities over the past 90 years, although a number have been conducted on a combination of audio and haptics (Guerreiro et al., 2013; Walker, 2016). Secondly, the two studies conducted on OVAL to date focus on literate individuals (Arbel et al., 2020; Arbel et al., 2022). While the first one studied sighted, literate adults who wore blindfolds, the second studied literate adults who are blind (Arbel et al., 2020; Arbel et al., 2022). Thirdly, the two studies conducted on OVAL to date focus on participants who are learning the code in their first language, Hebrew (Arbel et al., 2020; Arbel et al., 2022). There has been no exploration of the value of OVAL in second language literacy instruction. Finally, the two studies conducted are purely quantitative in that they strictly consider the results of OVAL training speed and accuracy, while not exploring the attitudes and perspectives of those participating in the studies (Arbel et al., 2020; Arbel et al., 2022). These limitations are addressed in the current study. In addition to studying the use of an auditory orthography, the research differs from the first two OVAL studies in that it considers adults who are preliterate. Preliterate is defined in this case as those who did not learn to read and write at the typical development stage. This study also adds the complexity of training participants in OVAL in a language other than their first. If OVAL truly is as easy and fast to learn as initial studies show, what are the results for people who are preliterate and learning it in a second, third or fourth language? Finally, the current study is mixed methods, considering both the results of the OVAL

training in terms of accuracy and the attitudes and perspectives of the participants, both those who would be considered learners and the instructor.

2.8 Research Questions

1. How effectively will OVAL audemes be learned and retained by preliterate EAL adults who have visual disabilities?

2. What is the attitude and perspective of the participants towards the OVAL modality as compared to braille?

3. What is the experience and perspective of an instructor towards teaching blind or visually impaired, preliterate, adult, English as an Additional Language learners to read using OVAL in comparison to braille?

3. Methods

3.1 Design Philosophy

This study followed a mix of pragmatic and advocacy/participatory approaches to methodology. The study aligns with the pragmatics approach in that it is problem-centred and related to real-world practice (Creswell, 2014); it investigates the limitations of literacy options for people who are blind or visually impaired and considers a solution. It also fits the pragmatics lens in that it uses both quantitative and qualitative data to understand and begin to address the problem (Creswell, 2014). Concomitantly, the study also takes an advocacy/participatory approach in that it is intended to assist in bringing about improvements in people's lives (Given, 2008). The study frames the provision of a new literacy technology and related opportunities for individuals who are blind or visually impaired as a social justice concern with implications for empowerment, equality, and inclusion (Creswell, 2014). A Likert-scale based survey and open-ended questions provide both quantitative and qualitative data; these data align with the advocacy approach's focus on providing opportunities for individuals to be heard in their own words (Given, 2008). In addition, post-assessments of reading knowledge provide quantitative data on the effectiveness of the OVAL reading system. Finally, a qualitative analysis of the experience of teaching OVAL as compared to teaching braille provides further insight into the affordances of a new orthography. The combination of qualitative and quantitative methods produces a strong analysis of the potential in the OVAL system as an alternative reading tool for people with visual disabilities. The use of multiple data sources, known as triangulation, allows for a comprehensive understanding of the research topic (Carter et al., 2014).

3.2 Participants

3.2.1 Instructor (Researcher)

As the instructor in this study, I have taught braille for more than three years. I am also certified by TESL Canada to teach English to speakers of other languages. For most of three years, my teaching workload included instructing several adults who were learning English as an Additional Language while also learning braille for the first time in their lives. Due to the pandemic, two of those years involved months of online teaching. I was highly aware of the unique challenges of teaching adults to read braille online in a language other than their first. I am also the researcher for this paper.

3.2.2 Learners

A total of seven adult individuals with visual disabilities took part in the research (age range: 20-30 years; 1 female, 6 males). All but one participant began learning English as an additional language between the ages of 15 and 25, with the sole participant learning it as a child. The participants' oral (speaking and listening) knowledge of English ranged from beginner level for four of them, intermediate for two, and advanced for one. The levels are based on an observational assessment by the researcher, who is a certified English as a Second Language instructor; the researcher drew on the Canadian Language Benchmarks for her assessments. All but one participant has been blind since birth, with the aforementioned participant becoming blind at the age of 11. Five of the seven participants are totally blind; one participant has some light perception, and one describes themselves as having a visual impairment. Five of the seven participants learned to read and write using braille between the ages of 15 and 25. One participant learned braille at the age of 11. Another participant learned to read and write at the typical literacy development stage, and then later learned braille after becoming blind. Thus, it

could be stated that all the participants learned to read and write braille well beyond the typical literacy development stage. This is in keeping with the definition of preliterate as noted in this current study. The seven participants live in six different countries and five different time zones. As the participants could not be assessed remotely in braille given their locations and the logistical barriers to remote assessment imposed by the nature of a tactile orthography, they were asked to self-report their proficiency in braille as either beginner, intermediate or advanced: three identified as beginner; two as intermediate; two as advanced. While there are perils to self-reporting, the participants were sufficiently self-aware, the stakes low, and the question framed in a clear and non-prejudiced way, thus promoting sufficiently credible responses (Fadnes et al., 2009). The participants referred to the number of years they have been learning braille and their reading speed as benchmarks of their levels. Three of the participants are learning braille in English, while the rest have learned or are learning braille in either their mother tongue or another language. None of them had been tested for neurological conditions (such as learning disabilities) or hearing abilities. All but two of the participants had never been exposed to the OVAL system; the two had received some exposure to the system as part of their English as an Additional Language course with the researcher who was also their instructor five months before. However, most of the letters in the current study were different from those the two participants had learned earlier; in addition, a pre-training test showed they had not retained remembrance of the letters they had learned earlier. The research was approved by the Research Ethics Boards of both Ontario Tech University and Fleming College, where two of the participants were completing an English course with the researcher who was also their instructor at the time. All participants received an audio file of the consent form (Appendix A) in their first language. The audio files were created by a translator/interpreter who was provided with a

written version of the consent form in the English language. The participants were also told a translator was available to help with questions about the study as needed. None of the participants asked for help from the translator in understanding the consent form. The translator signed a confidentiality form before taking part in any of the translation work for this research. To provide consent, the participants were asked to send an audio message and/or text message to the researcher stating that they agreed to participate in the study, as well as stating that their anonymized data could be shared with the developers of OVAL. All participants received monetary compensation for their participation. Three of the participants chose to donate their portion to a fourth participant who is living in difficult circumstances. A summary of the participant profiles is available in Table 1 below.

Table 1

Learner Participant Profile Overview

Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Gender	**Male**	**Male**	**Female**	**Male**	**Male**	**Male**	**Male**
English language proficiency	**Began learning at 23 years; beginner**	**Began learning at 24 years; beginner**	**Began learning as youth/adult (between 15 and 25 years); beginner**	**Began learning as youth/adult (between 15 and 25 years); beginner**	**Began learning as a child; advanced**	**Began learning as a youth/adult (between 15 and 25 years); intermediate**	**Began learning as a youth (16 years); intermediate**
Vision features	**Totally blind since birth**	**Totally blind since birth**	**Totally blind since birth**	**Visually impaired since birth**	**Became blind at age 11; totally blind**	**Totally blind since birth**	**Has some light perception; since birth**
Braille knowledge	**Beginner** **Learned braille at 23 years; learned in English**	**Beginner** **Learned braille at 24 years; learned in English**	**Beginner** **Learned braille at 23 years; learned in a language other than English**	**Beginner** **Learned braille at 27 years; learned in a language other than English**	**Advanced** **Learned braille at 11-12 years; learned in a language other than English**	**Advanced** **Learned braille at 11 years; learned in a language other than English**	**Intermediate** **Learned braille at 16 years; learned in English**

3.3. OVAL System

The OVAL system was developed by a team at the Hebrew University of Jerusalem: Dr. Roni Arbel, Dr. Benedetta Heimler, and Dr. Amir Amedi. Referring to strong evidence for the value of reading by decoding, and the significant need for alternatives to a tactile-based orthography that is essentially the only option for people who are blind (Arbel et al., 2020), the team developed an auditory-based alphabet they have named OVAL. "[E]vidence clearly suggests that typical reading acquisition exerts many benefits for neural and behavioral efficiency, thus highlighting the great need to create additional and alternative full reading options for the blind and visually impaired population which in turn rely not only on language understanding (as audio listening technologies), but also on active word decoding (as print-reading systems)" (Arbel et al., 2020, p. 3). The team identified that they were aiming to develop an alternative orthography that would be "cheap, easily accessible, as well as both relatively easy and quick to master also in adulthood" (Arbel et al., 2020, p. 3). The characters of the OVAL alphabet are called "audemes," and have been created based on features of both the braille and Morse code systems (Arbel et al., 2020). The team created two versions of OVAL, with one of them, referred to as the Color group, featuring the addition of certain musical instruments in order to facilitate the further differentiation of the audemes. An initial study by the Hebrew University team showed a greater level of accuracy with the Color group (Arbel et al., 2020); given this success, the current study used the Color group version, although it will simply be referred to as OVAL through the remainder of the paper. The Hebrew University team conducted research on OVAL with 18 sighted participants who were blindfolded (Arbel et al., 2020); a publication is forthcoming on additional research they have conducted with participants who are blind (Arbel et al., 2022). The current study is intended to offer insight from yet another perspective as it tests OVAL with

participants who are blind and preliterate, meaning they did not learn to read and write at the typical development stage, and who were exposed to OVAL in a language other than their first. While the one participant did learn to read and write at the typical development stage as a sighted person, he did not learn braille until after he became blind at the age of 11. The current study is also a mixed methods study as it includes both quantitative and qualitative research. The Hebrew University team provided significant support for my research as they met several times with me and my supervisor to provide instruction and training on OVAL; they also supplied the computer program which generates the OVAL audemes, EyeMusic 4.59 SSD (Sensory Substitution Devices), to allow for the training with participants. They enthusiastically await the findings on the value of OVAL for developing EAL literacy skills.

3.4 Data Collection

3.4.1 Overview

My research included collecting the following types of data: quantitative data in the form of both post-training assessment results and Likert-scale survey questions, and qualitative data in the form of open-ended questions and instructor observations. The post-training assessment results provided a quantitative assessment of participants' retention of OVAL audemes following the training in OVAL. The Likert-scale survey questions provided a quantitative overview of participants' perspectives on learning both braille and OVAL. The data from the OVAL assessment results, the survey, and the participants' braille levels were then correlated using Spearman Rho. The open-ended questions gave participants an additional opportunity to share their thoughts on learning and using both braille and OVAL. The final component of data collection is a chart summarizing the researcher--as--instructor's observations of the affordances available in both the braille and OVAL systems.

Table 2

Overview of Data Collection Tools

Research Question	Data Collected	Item
1. What are the results of an OVAL training session for blind or visually impaired, preliterate, adult, English as an Additional Language students?	Quantitative: Post-training audeme recall assessment	Appendices E, F
2. What is the attitude and perspective of the participants towards the OVAL modality as compared to braille?	Quantitative and Qualitative: Post-training survey and open interview questions	Appendices C, D, G
3. What are the observations of a instructor on teaching blind or visually impaired, preliterate, adult, English as an Additional Language learners to read using OVAL in comparison to braille?	Qualitative: Post-training observations	Table 10

3.4.2 OVAL Training

For the OVAL training, the seven participants joined the researcher in an online video-conferencing platform for approximately two hours. The group training was scheduled for a time that suited the participants as they joined from five different time zones. The participants had been informed in the consent letter that they would be learning letters of the English alphabet in OVAL, followed by an assessment of their OVAL audeme recall, an interview about their experiences and opinions on both OVAL and braille, and a survey. The researcher chose to focus on the following nine letters: p, e, a, i, o, u, r, d, s. Time to practice blending the letters was intentionally included. The inclusion of time to practice blending takes into account one of the

additional components of learning to read, namely, phonological awareness (Frank & Perry, 2015). While knowledge of alphabet letters is a key preliminary element of learning to read, the additional foundational skills include phonological awareness, phonics and word recognition, and finally fluency (Frank & Perry, 2015). The scope of this research could not address all of the foundational skills, but by adding in at least preliminary practice of the phonological component, the researcher could gather a more comprehensive understanding of the potential of OVAL. After explaining the OVAL system, which the participants had also learned about in the consent letter, the researcher began the process of teaching the audemes. Using the EyeMusic 4.59 SSD system provided by the Hebrew University of Jerusalem team, the researcher introduced each audeme in turn, playing each one multiple times. After hearing the OVAL audeme several times, participants were invited to call out the name of the letter. This was intended to provide recall practice. After each audeme had been learned by the group, the researcher alternated between the audemes already learned, so that the participants could practice identifying which one they were hearing. They were encouraged to call out the letters as they recognized them. After five of the audemes had been learned, the group took a 15-minute break. They then learned the remaining four audemes. Following the letter training, the group practiced listening to and identifying blends of the letters they had learned. This approach is known as the synthetic approach to reading, which starts with learning and identifying the individual letter-sound patterns, followed by blending, and then segmenting of recognizable words (Frank & Perry, 2015). For example, the participants first learned a series of letters, including vowels and consonants. They then learned blends of those letters, such as pa, pe, pi, po, ap, ep, ip, op. The order of letters and sequence of the blends is documented in Appendix E. The sequence of blends is based on a program for teaching literacy to adults with learning difficulties (Moore, 2002). The choice to

use this program was made given that all but one of the participants learned to read and write after the typical learning-to-read stage, and that they did so using a non-typical orthography. While the participants may not have learning difficulties due to intrinsic challenges such as a learning disability, they certainly have extrinsic or environmental barriers to overcome. As Moore (2002) notes, "There can be a number of different causes of an adult's reading and writing difficulties. In some cases, this kind of problem is due to a lack of educational opportunity; or to the fact that the adult was educated in another language… The diagnostic and teaching strategies here will be useful for students with and without learning disabilities" (p. 1). The blends were played using EyeMusic and the participants were encouraged to "read" the blend they were hearing, that is, to say the letter combination/word they were hearing, such as "po," rather than each letter separately, for example, "p" and then "o."

3.4.3 OVAL Assessment

Immediately after the OVAL training, the videoconferencing call was closed. On the same afternoon, within the span of four hours, each participant was then contacted separately using either WhatsApp or Zoom to conduct the OVAL audeme recall assessment and answer the interview questions. This arrangement was intentional, to avoid having the participants influence one another's thoughts by interviewing them as a group, or even by having them wait in an online room together while the researcher interviewed each one separately. For the OVAL assessment, the researcher played each of the nine audemes that had been learned. Participants could request to have the audeme replayed as many times as they wished. They were then given the chance to identify the English letter that the audeme represented. They could correct themselves after listening to additional audemes. That is, if they realized that they had incorrectly identified an audeme after hearing subsequent audemes, they had the option of changing their

original choice. The researcher only measured recognition of the nine audemes; speed, mastery of blends, and number of repetitions required for correct identification were not measured. This was intentional, to avoid stressing the participants after only a short training session, a risk potentially greater given the research was conducted in the late stages of the pandemic, as noted in Goldfarb's research (2020).

3.4.4 Interviews

Immediately following the OVAL assessment, the researcher conducted an interview with each of the participants about both their OVAL and braille learning experiences. In all but one of the cases, the participants were asked the questions orally via WhatsApp or Zoom, and their answers recorded. In the one instance, the participant asked for the questions to be sent in English via text, and they then answered in English via text. In three of the cases, at the participants' requests, a translator was present to help with understanding the questions and expressing responses. The interview questions are included in Appendix C.

3.4.5 Surveys

Following the interview, the participants were sent a link to a Likert Survey using SurveyMonkey. They were asked to complete the survey within the following two days. They were also told that if they had challenges with accessing the survey, the researcher could send the questions via WhatsApp. In five instances, the participants were able to open the survey and answer the questions. Due to their developing proficiency in using computers, two of the participants required the researcher to ask the questions and mark their answers in SurveyMonkey. An interpreter was not requested for the survey by the two participants. See Appendix D for the survey questions.

3.4.6 Observations on OVAL from an Instructor's Perspective

As a certified instructor of English as a Second Language, and a certified braillist, I, the researcher, provided observations on my experience of teaching the participants OVAL. I compared the experience of teaching adults who are blind or visually impaired to read using braille with the experience of teaching adults who are blind or visually impaired to read using OVAL. My observations were based on nine key considerations when teaching a group of people to read, adult or child, sighted or not. These considerations were drawn from my experience as an instructor of both sighted and blind adults and children, as well as from my extensive research of the relevant literature as an instructor holding a pedagogical framework shaped largely by the communicative lens. Thus, while the initial three components of this study focus on the student (participant) experience and perspective of OVAL as compared to braille, this part of the research considers OVAL in comparison to braille from an instructor's experience and perspective.

3.4.7 Data Analysis

Statistical analysis of the survey data was conducted using IBM SPSS (Statistical Package for Social Sciences) Statistics 27 software, using Spearman Rho tests. Descriptive statistics of mean and standard deviation of the post-training OVAL assessment results were derived also using IBM SPSS Statistics 27 software. Frequency distribution of the Likert-scale based survey responses was formulated through SurveyMonkey. Qualitative analysis of the interviews was conducted in part using ATLAS.ti, a software program that assists with coding transcripts.

Table 3

Overview of Data Analysis Methods

Research Question	Data Analysis Methods
1. What are the results of an OVAL training session for blind or visually impaired, preliterate, adult, English as an Additional Language students?	Descriptive statistics of mean and standard deviation of the post-training OVAL assessment results
2. What is the attitude and perspective of the participants towards the OVAL modality as compared to braille?	Descriptive statistics and a frequency analysis were done on the survey; A Spearman Rho correlated the survey results with the OVAL assessment results and braille levels; Grounded Theory was used to code the interview responses
3. What are the observations of a instructor on teaching preliterate, adult, EAL learners who have visual disabilities to read using OVAL in comparison to braille?	Post-training observations contrasted the based on evidence-based strategies for

4. Findings

4.1 Overview

This study looked at the following research questions:

1. How effectively will OVAL audemes be learned and retained by preliterate EAL adults who have visual disabilities?

2. What is the attitude and perspective of the participants towards the OVAL modality as compared to braille?

3. What are the observations of an instructor on teaching blind or visually impaired, preliterate, adult, English as an Additional Language learners to read using OVAL in comparison to braille?

4.2 Retention of OVAL Audemes

4.2.1 Experiment 1 – OVAL Audeme Identification Task Among 7 Participants

The seven participants were individually assessed in letter identification in OVAL. With all but one participant, the assessment was conducted via WhatsApp; the remaining assessment was conducted via Zoom as the participant could not video-call using WhatsApp. While having the students co-located may have improved sound quality (although not necessarily), the remote assessment was necessary due to the locations of the participants. There were no identified challenges with bandwidth during the training, assessment, and interviews. The nine letters were presented in the same order for each participant, following the literacy program for adults outlined by Moore (2002): *p, e, a, i, o, u, r, d, s.* The audeme was played by the researcher on the EyeMusic program, hosted on the researcher's laptop computer. To listen to each audeme, see Appendix F. The participants heard the sound through the audio on WhatsApp or Zoom. All participants heard the sequence of audemes in the same order. The order of audemes in the assessment followed the order in which the audemes had been presented during the training

period. The participants were allowed to hear the sound of each audeme repeated as many times as they wished. In all cases, the most repetitions requested were three. The participants were asked to identify the name of the letter they had heard, rather than a specific pronunciation of the letter. The assessment with each participant was completed in less than 5 minutes each. The results are summarized in Table 4: Overall percentages on the audeme recognition task ranked from 33% to 100%, with a mean of 6.43 or 71.29 % and a standard deviation of 2.70.

Table 4

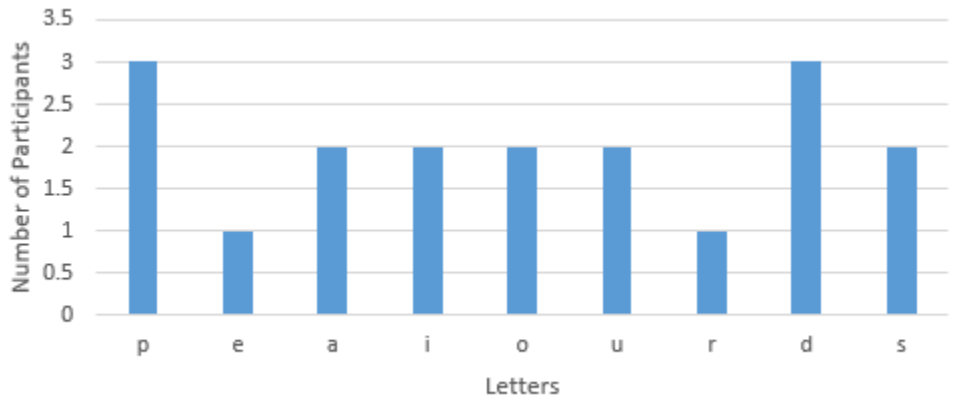
Descriptive Statistics of OVAL Audeme Assessment

Number of participants	Minimum score (number of correctly identified audemes)	Maximum score	Mean	Std Deviation
7	3	9	6.43	2.70

The pattern of audemes incorrectly identified are summarized in Table 5 . A greater number of participants identified the audemes p and *d* incorrectly, while a greater number identified the audemes *e* and *r* correctly.

Table 5

Number of Participants who Identified the Noted Audemes Incorrectly



4.2.2. Experiment 2 – Letter Identification Tasks in OVAL and Braille Among 2 Participants

Based on their proximity to the researcher (as students in my class), two of the participants could also be assessed in braille, offering a sampling of the differences in results that one might anticipate between the two orthographies. Unless one has access to partner researchers, instructors, family or friends who have a knowledge of braille, it is difficult to conduct braille assessments remotely via computer (that is, with the instructor/researcher providing the letters to be tested in one location and the student/participant identifying the letter in another location). The participants would need to receive the materials via mail; also, parameters would need to be set in place to ensure the validity of the testing, which is also difficult to confirm given the remote connection. The two participants, coded 1 and 2, completed the same OVAL letter assessment via WhatsApp as the rest of the participants, following the two hours of online training. They were also assessed in person on the same nine letters in braille. The in-person assessment was completed at the post-secondary institution where the students' English language training by the researcher took place. The participants completed the braille assessment on different days than the day of the OVAL training and assessment. The two participants were not

in the same room as one another when completing the assessment. For the braille assessment, each participant was given the braille paper and asked to read the letters. The letters were provided in the same order as they had been in the case of the OVAL assessment: p, e, a, i, o, u, r, d, s. Each participant was given as much time as they needed and allowed to correct themselves. Participant 1 identified two letters incorrectly at first, and then identified them correctly later: Letter p was initially identified as v, and letter u as m. Participant 1 also identified the following letters incorrectly: i and e. Participant 2 identified all but two of the letters incorrectly: a and o. Both participants completed the braille assessment in less than 5 minutes each.

As mentioned earlier in the paper, these two participants have received approximately 70 hours of education in braille since the fall of 2019. Due to the COVD-19 pandemic, their training has been marked by interruptions of up to several months which consisted of little to no practice in braille reading. The online practice in which they were able to participate consisted of verbally recalling the cell numbers of each braille letter; for instance, the letter “a” in braille is dot 1, the letter “b” is dots 1,2, the letter “c” is dots, 1,4, and so forth. The overall results of the two participants’ assessment in both braille and OVAL are summarized in Table 6, with a mean of 100% in OVAL compared to 44.5% in braille.

Table 6

Descriptive Statistics of Oval and Braille Letter Assessment Results for 2 Participants

Orthography	Minimum Score Out of a Total of 9 Achieved	Maximum Score Out of a Total of 9 Achieved	Mean	Std. Deviation
Braille	2	7	4.50	3.54
OVAL	9	9	9.00	.000

Table 7

A Comparison of the Number of Braille Letter Errors

Braille Letters	**p**	**e**	**a**	**i**	**o**	**u**	**r**	**d**	**S**
1 identified incorrectly		x		x					
2 identified incorrectly	x	x		x		x	x	X	X

As is the case with OVAL, several orthographies feature pairs or groups of letters that are quite similar. With respect to OVAL, participants identified that, of the audemes they had learned thus far, the audemes *p* and *d* were especially similar. In braille, e and i have been

identified as similar, as have other pairs or groups of letters. In the Roman alphabet, letters which look very much the same also exist, including b and d. Morse code, which the OVAL team drew upon, also features similar-sounding letters, among them a and n. The characters Б and Ъ in Russian Cyrillic provide another example of “twin-like” letters. Thus, a number of orthographies include similarly-featured characters, which could lead to a higher incidence of those characters being incorrectly identified as they are mixed up with the characters that they resemble so closely.

4.3 Attitude and Perspectives on OVAL Versus Braille

4.3.1 Likert-Scale Based Survey of Participants

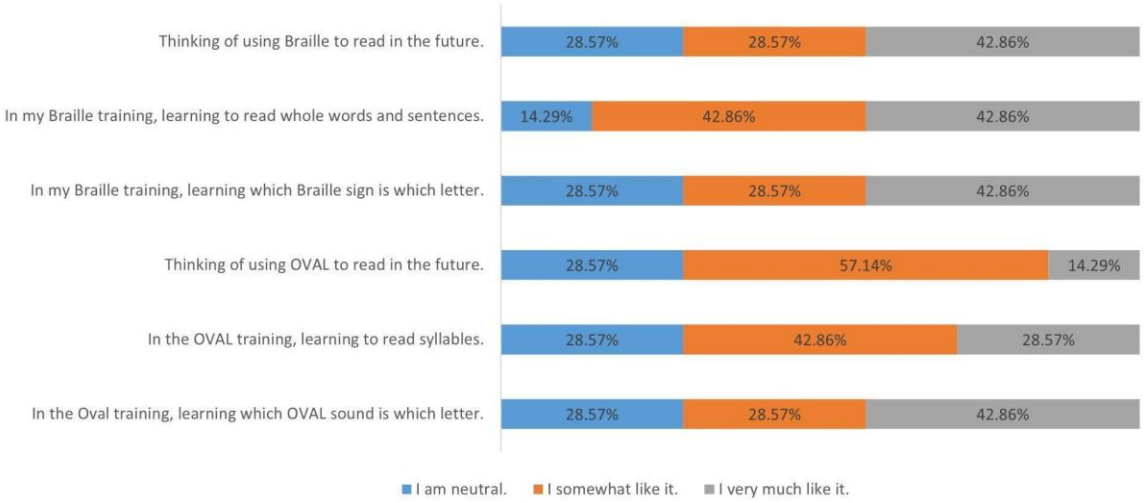
Following the on-line training, assessments, and interviews, the seven participants were sent a link to a Likert survey designed using SurveyMonkey. The survey questions are included in Appendix C. The participants were given the option of receiving support to answer the questions via WhatsApp, if they preferred. In one case, a participant was sent the six questions with the five possible responses via WhatsApp text. However, this participant was able to complete the survey using the SurveyMonkey link. In the case of two participants, because they did not understand how to use the survey and did not have support available in their home, the questions were read to them by the researcher. No request for the interpreter was made. The researcher then filled in their answers on SurveyMonkey. All participants were given the option of completing the survey on the same day, or within the next one to two days. All seven had completed the survey by the end of the second day. The frequency of the answers to the survey questions by the seven participants is documented in Table 6 below.

The question about the experience of learning OVAL and braille letters had the same ratio of responses, that is, the same percentage of participants either were neutral, somewhat liked it, or

liked it very much. In contrast, a higher percentage of participants liked their experience of learning to read braille words and sentences as compared to learning to read OVAL syllables: 42.86% as compared to 28.57%. With regards to the questions about thinking of using either braille or OVAL to read in the future, the same percentage were neutral, but a higher percentage "very much liked" the thought of using braille to read in the future, as compared to OVAL: 42.86% as compared to 14.29%. Table 8 provides an overview of the frequency distribution of the responses. As the options, "I very much do not like it," and "I somewhat do not like it" did not receive any participant responses, they are not included in the table.

Table 8

Frequency of Likert Survey Responses to Questions about OVAL and Braille



Spearman Rho Correlations. The correlations between participant responses to two survey questions (thinking about using braille in the future and thinking about using OVAL in the future) and either their braille levels or OVAL assessment results were analyzed using Spearman Rho (Tanner, 2012).

To start, the correlation between the participants' level of braille proficiency and their

response to the question about “thinking of using braille in the future” was analyzed using the Spearman Rho test via IBM SPSS Statistics 27. The braille proficiency level was assigned 1, 2, or 3, for beginner, intermediate, or advanced respectively. The Likert scale responses were assigned the following values: 1 (I very much do not like it); 2 (I somewhat do not like it); 3 (neutral); 4 (I somewhat like it); 5 (I very much like it). The Likert responses were identified as ordinal values, while the braille levels were identified as scale. As shown in Table 9, the Spearman Rho test showed no significant correlation between the level of braille and the interest in using braille in the future.

Similarly, the correlation between the participants’ level of braille proficiency and their response to the question about “thinking of using OVAL in the future” was analyzed using the Spearman Rho test via IBM SPSS Statistics 27. As also shown in Table 9, the test showed no significant correlation between the level of braille and the interest in using OVAL in the future.

The correlation between the level of success in OVAL and the response to the survey question about “thinking of using OVAL in the future” was also analyzed using the Spearman Rho test. The Oval level was assigned 1 to 9 for success rate, meaning the number of errors out of a total of 9. As above, the Likert scale responses were assigned values of 1 (I very much do not like it); 2 (I somewhat do not like it); 3 (neutral); 4 (I somewhat like it); 5 (I very much like it). While the Likert response was identified as ordinal value, the OVAL level was identified as scale. This time, the Spearman test showed a significant and positive correlation between OVAL level and the interest in using OVAL in the future. See Table 9.

In contrast to the above, the level of success in OVAL did not produce a significant correlation with participants’ interest in using braille in the future. The same analysis was conducted as described above, but this time with the insertion of the Likert responses to the

question about using braille in the future; these responses were correlated with participants' success in OVAL. As Table 9 shows, there is not a significant correlation.

Table 9

Spearman Rho Correlations Between Survey Questions and Braille Levels and OVAL Assessment Results

	Thinking of using Braille in the Future	*Thinking of Using OVAL in the Future*	*Level of Braille*	*OVAL Audeme Assessment Results*
Thinking of Using Braille in the Future	1.0		-.75*	.37
Thinking of Using OVAL in the Future		1.0	-.59	.77*
Level of Braille			1.0	
OVAL Audeme Assessment Results				1.0

Correlation is significant at the 0.05 level (2-tailed).

4.3.2 Interviews of 7 Participants on Braille and OVAL

Grounded Theory (Delve & Limpaecher, 2021) was the basis of the qualitative analysis conducted on the participant responses to the interview questions. Allowing for the deduction of new theories, grounded theory can help guard against confirmation bias as the researcher "allows the data…to guide…analysis and theory creation" (Delve & Limpaecher, 2021, para. 7).

An inductive approach was taken, in which transcripts of participants' interview responses were first examined for patterns. Those patterns were assigned codes. This process is referred to

as open coding (Delve & Limpaecher, 2021). The interview transcripts were studied further, and patterns between the codes were identified, including similarities and correlations. This process is referred to as axial coding (Delve & Limpaecher, 2021). The codes were then grouped according to similarities and correlations, ultimately resulting in seven themes.

To illustrate the process, accessibility (one of the seven themes) was arrived at in the following way: after the open coding process, six selective codes were identified as follows: accessibility of OVAL; benefits of OVAL; access to braille; remote learning reference; braille versus technology; these six codes were collapsed into the theme of accessibility. See Appendix G for a coding chart detailing the codes and corresponding themes.

The seven identified themes are as follows: accessibility, expanded opportunities, ease of learning, sensory experience of reading, reading by decoding, ease of use, and interest in future OVAL use. The themes will be further explained, with reference to participant comments, below.

Atlas.ti software was used to both identify and create a visualization of the connections between the themes. The connections are separately addressed under the categories of contradictions, links, properties, and parts.

The participant responses are provided verbatim, with grammar and word choice errors included. They answered in English in most cases; three of the participants answered through a translator for some questions.

Specific themes. ***Accessibility.*** The theme of access to either of the orthographies featured in participant responses. Two participants mentioned the benefit of OVAL as an orthography that is accessible online. The same participants noted this could be especially valuable should schools be closed again, as they were intermittently throughout 2020-2022 due to pandemic restrictions.

> OVAL is very good online… For example, if a school got closed again or

> teachers cannot mail them (braille materials), OVAL would be very helpful. (Participant 7)

> I see that OVAL could be a possible good way to be learned if the circumstances of learning braille (have) not been met. For example, when we were at the beginning of the COVID 19 pandemic, it was not that possible to learn braille since it depends mainly on touching, and that was one thing that had to be reduced at that time. Therefore, OVAL in that case might be helpful as an extra learning possibility. (Participant 3 through a translator)

In responses by two other participants, the accessibility of OVAL was discussed in terms of its integration with systems that they already use in their daily lives, primarily voice-over on their mobile phones and screen readers on their computers. The participants noted they would use OVAL if it could be integrated into these existing systems.

In contrast to the accessibility of Oval, one participant noted that in the country where he currently lives, braille materials and signage are widely used and accessible. For that reason, he said he did not imagine himself being interested in learning and using OVAL. Another participant noted the accessibility of braille as a positive feature in contrast to OVAL.

> Braille letters are a more practical way because they can be used anytime and anywhere. (Participant 4)

Expanded Opportunities. Three participants referred to the potential opportunities that learning OVAL could add to their lives. In all three cases, the participants noted they did not imagine OVAL becoming a substitute for braille; however, they did note that it could be a valuable "extra."

> I think it is another way, but it is not a substitution for braille. Removing the braille system (would be) something really hard but using (OVAL) as an extra learning (could be helpful). (Participant 3 through a translator)

Two participants identified potential future employment or volunteer opportunities through their knowledge of OVAL.

> Maybe I can help another blind (person) and that will be as a job or another skill for me. (Participant 6)

> It's a very good skill to have. For example, if you became a teacher or something and if you meet a student who doesn't want to read braille, (OVAL) is another great option to have. For example, if they're having a hard time to understand the audio, it's not their language, (you could use OVAL then too). There are a lot of things that OVAL could help with. It's a great thing to have. (Participant 7)

Ease of Learning. Only one of the seven participants identified OVAL as easier to learn than braille. Four of the seven participants noted the similarities between some of the OVAL letters as a reason for it being a challenging orthography to learn.

> Oval is harder because there are a lot of similarities between the letters. As I (am not) used to differentiating between the short digital sounds, I can see that something we touch directly could be (more) easily recognized than if it is heard as a digital short sound. (The) difference between braille letters are recognizable since the similarities are such a letter and the other way around of it, like the "h

> and j" in braille, they are similar, but they could be easily and directly identified. (Participant 3 through a translator)

> Certainly, it is difficult to distinguish between letters… and then collect them in a word or sentence. (Participant 4)

One participant noted that if OVAL were to be fine-tuned, with additional changes in pitch or length of sound, in order to make the audemes even more distinct from one another than they are currently, it would be easier to learn.

Two other participants referred to the speed of reading that OVAL allows for. One suggested that the introductory sound before each word slows the reading process. While research identified in the literature review shows hearing is much faster than touch, another participant noted that he believes that reading by touch allows for faster processing than reading by sound.

> Speed in braille is faster than OVAL because OVAL needs to focus on the sense of hearing and focus. As for braille, it uses touch and focus, therefore, braille is faster to deliver information to the brain. (Participant 4)

In two participant responses, the challenge of learning a new orthography after working so hard to learn braille was raised. While all the participants learned braille as older children (age 11), teens or adults, these two participants have just started learning braille in the past two years as adults.

> Since we have read braille before, it (OVAL) is getting a little bit hard for us, because we never did this before. (Participant 2 through a translator)

The sole participant who identified OVAL as easier to learn has not been blind from birth, as have the other six. He noted that the hearing sense is much more “qualifiable” than the touching sense.

> When I hear something, I can recognize it better than touching it. It’s much easier to identify (things) that are heard than that are touched. (Participant 5)

Sensory Experience of Reading. Five of the participants referred to the difference in experience between hearing the OVAL sounds and feeling the braille letters. In two instances, the participants suggested that using the sense of touch provides either a better or easier reading experience.

> Between Oval and braille, braille is (better) because I will use sweeping my finger on braille paper. (Participant 1)

> I think it will be difficult for me because learning braille is easier because of the sense of touch. (Participant 4)

Two participants suggested that using the sense of hearing provides either a better or easier reading experience.

> I think that the hearing sense is much more qualifiable than touching sense. I can't really express what I want to say but when I hear something I can recognize it better than touching it. It's much easier to identify (things) that are heard than that are touched… I love depending on my hearing ability rather than the touching one. (Participant 5)

> (OVAL) is a great thing to learn anyway. It's a good thing to have. A lot of people don't want to touch anything. I like when I read braille, but I'm sometimes getting to a point where I don't want to touch it….so that's when OVAL is great. (Participant 7)

Reading by Decoding. All but one of the seven participants noted the importance of reading by decoding to some degree.

> Because of my depending on the screen readers. I now am having a problem with spelling. That's because I used to for example with the name Natalie, I used to hear it and then process it symbol by symbol… Now I have a problem with spelling because I left braille, and I don't read something that depends on processing symbols. That's why it is important.
>
> So, screen readers are not enough. Because we get in need sometimes to know the spelling of a word or even know more details about the written text that are not informed by the screen reader. In braille or OVAL, I have an imagination of each and every written character in my mind, but when using the screen reader, I don't.
>
> (However, reading by decoding) needs a bit of time. It's much easier to read a paragraph with a screen reader than reading it by processing, I mean braille or OVAL. (Participant 5)
>
> It's very important (to read by decoding), just take care of yourself, be more independent. (Participant 7)

> I can say (reading by decoding is important) because I cannot trust the screen reader, because maybe it will say some words by mistake. (Also, reading by decoding can allow) for our privacy with other people, so they don't understand what we read. And, of course, in our feeling, if we read (by decoding) we can be more understanding and successful… We can think more about what we read (because we are reading letter by letter). (Participant 6)

Ease of Use. While the majority of participants suggested they understood there is some value in reading by decoding, all of them referred to their use of screen-reading and/or voice-over technology. The three below suggest screen-reader technology offers an easier, faster, and/or better alternative to reading by decoding.

> Certainly, I do not read (braille) because there is a technology complete with all of our requirements. (Participant 4)

> It's much easier to read a paragraph with a screen reader than reading it by processing, I mean braille or OVAL. (Participant 5)

> The screen reader is better than OVAL and braille. It says each letter. It reads the words. (Participant 1 through a translator)

Interest in Future Oval Use. Two of the seven participants said they would likely read more in English if they learned OVAL.

> I think maybe yes because the same reason I mentioned in the first question because I love depending on my hearing ability rather than the touching one.

> However, I think it needs more focusing, but I think it would be better for me specifically. (Participant 5)

> It depends on the things that are happening here. If school got closed, that would be a great idea. (Participant 7)

One said he could not imagine himself reading more in English than he does now if he learned OVAL.

> For me, I think not. Why? Because I learned braille and in English we have enough books and journals (and other content) all in English. (Participant 6)

However, when asked if they would learn and use Oval if the developers create an app, five participants said they would.

> That would be super fun. That would be great. (Participant 7)

The two who said no seemed to hold a certain loyalty to braille.

> No, I am not using OVAL every time. Just research. For me, every time braille. (Participant 1)

Atlas.ti software was used to both identify and create a visualization of the connections between the seven themes. The connections are visually depictured in Figure 1.

Figure 1

Connecting the Themes in the Participant Responses on OVAL and Braille

Contradictions

While ease of use is discussed as an important feature of a system that allows one to read text or hear text being read, other elements that are not necessarily easy to use or experience are also mentioned as important considerations. These include the ability to read by decoding and the sensory experience. Although it may be easier to have a screen reader dictate text, there is an understanding that the ability to read by processing symbols has value. In addition, the sensory experience of feeling the braille dots or listening to the OVAL audemes, although requiring more concentration and engagement than simply listening to a text being read, appears to be viewed as worthwhile.

Links between themes

A linkage between accessibility and ease of use exists as OVAL offers a way for a person who is blind or visually impaired to read by decoding without having to depend on access to braille papers. OVAL has significant potential to be more accessible than braille, although it has yet to be integrated with computer and phone systems. While there may be some hesitancy about adopting a new orthography, OVAL's potentially greater accessibility will mean it is that much easier to use.

A link also exists between the interest in future OVAL use and the sensory experience that both braille and OVAL offer. The future of OVAL is likely to be entwined with people's sensory preferences. It may even be that readers will switch between the orthographies, depending on how they feel; as one participant suggested, sometimes they grow tired of feeling dots and like the idea of having an alternative system for reading, one that engages a different sense.

Finally, ease of learning links to ease of use. Although the linkage may not be as straightforward as an orthography that is easy to learn will automatically be easy to use, there is a

connection. It may in fact be that an orthography that is difficult to learn is ultimately easier to use as added effort is put into mastering it.

Properties

If a property is defined as an attribute of something, there is indication that ease of learning may be a property of the sensory experience. When participants refer to enjoying a particular sensory experience related to an orthography – the tactile in the case of some, auditory in the case of others – it appears to be related to how easy they find it to learn.

Parts

Both the accessibility of OVAL and the opportunities it might provide are part of the interest in using OVAL in the future. As OVAL is not reliant on physical co-location in order to learn or use it, it is perceived as a viable "back-up" should education ever be forced exclusively online, as it was during the COVID-19 pandemic of 2020-2022. There appears to be an awareness that simply having it in one's back-pocket, so to speak, in case of "emergency" could be a smart choice. Some may not necessarily be interested in learning it for current everyday usage, including schooling, work, or socializing, but – like the generators some have purchased since experiencing days-long power outages – participants are interested in storing the knowledge of OVAL "just in case."

Similarly, while there does not appear to be a strong appetite for OVAL as a substitute for braille or screen readers in participants' current, everyday life a sense that the knowledge of it could open doors to jobs or volunteer opportunities did surface. In other words, participants may not be eager to switch to a new orthography for their own reading benefit and pleasure, but if they could, for example, use it to teach someone else how to read online, learning it might be worth their time and effort.

4.4. Instructor Observations on the Affordances of Braille and OVAL

The following table contrasts the affordances of OVAL and braille from the perspective of the instructor within the context of evidence-based strategies for teaching reading as well as other factors. As the instructor, I have three years of experience teaching braille, two of those in a primarily online context due to the pandemic. I am also certified through TESL Canada to teach English to speakers of other languages. The majority of my braille teaching experience has involved teaching adults who were also learning English as an Additional Language. That is, I was teaching preliterate adults who were learning English as an Additional Language. Preliterate in this context refers to adults who did not learn to read and write at the typical development stage. The various criteria in the table were drawn from my experience as an instructor holding a pedagogical lens that is largely shaped by the communicative approach. The citations refer to research on the evidence-based strategies for teaching reading in general as well as other factors.

Table 10

Instructor Observations on the Affordances of the OVAL and Braille Systems

Criteria	**Features of OVAL within the Context of Teaching Preliterate EAL Learners who are Blind or Visually Impaired to Read**	**Features of Braille within the Context of Teaching Preliterate EAL Learnerss who are Blind or Visually Impaired to Read**
Shared reading (Mitchell, 2018)	OVAL allows for synchronous, collective reading as a group. This might be compared to a teacher showing text on a Smartboard, whiteboard, or blackboard, and having learners read along. A version of this approach is called shared reading.	Braille can allow for synchronous reading in that each participant may have a braille paper with the same text. However, for EAL learners who are just beginning to learn to read, collective reading as a group is much more difficult. Close intervention is imperative to ensure the reader is following along on the correct braille cells. If students are learning virtually, this close intervention is especially difficult, more so when the students are also learning in a language other than their first (as in the case of EAL learners).
Peer support (Bethel, 2017)	Readers, including EAL learners, are able to support one another in identifying and understanding text as they simultaneously hear the same audemes.	Readers of braille may support one another, but verification is needed to ensure they are all on the same braille cells, that is, speaking about the same text. In the case of beginner EAL learners, providing this verification is more difficult (unless the students speak the same first language) than if they are more advanced EAL learners.

Repetition (Ghazi-Saidi & Ansaldo, 2017)	OVAL allows for spontaneous flexibility with regards to repetition of sounds or words. As the teacher is teaching, it may become apparent that students need extra practice with certain sounds, words, and/or larger chunks of content. A replay of the audemes may be done on the spot.	Braille allows for repetition of sounds or words. Students can be asked to move back to certain braille cells to repeat. However, the process requires ensuring the students are first on the correct cell or group of cells before having them repeat. Once again, with the beginner EAL learners, this may be more difficult to confirm.
Remote learning (MacKenzie, 2021)	Even as EAL learners can take part in synchronous, collective reading of OVAL text, they may be in time zones around the world. This is true whether they are advanced, intermediate or beginner EAL learners.	For beginner EAL learners who are also in the early stages of learning braille, in-person learning is vital – unless the student has in-person support in their home such as a parent or friend to help understand and follow some of the basics of reading in braille, such as orienting the paper, trailing text from left to right, learning which braille cell is which, and so forth. The challenge when they are learning English and braille remotely is that they cannot follow visual instructions due to their visual challenges nor understand spoken instructions due to the language barrier. In some cases, they may have in-person support, but, especially in the case of adults, they may be reluctant to rely on family or friends for this support.
Accommodations (Young et al., 2019)	Some students may require certain accommodations, such as the text being presented more slowly or, in the case of OVAL, more loudly. OVAL allows for certain accommodations for	Braille cells may be offered in larger sizes to accommodate students who struggle to feel the tiny dots. This requires accessing the larger sizes from the appropriate providers. In Canada, there are opportunities

	special needs, namely, adjustment of speed and loudness.	through associations that support people who are blind or visually impaired to access the larger dots. However, this is not necessarily the case for people in other countries.
Access to equipment and materials (Martiniello, 2022)	OVAL requires a computational device such as a mobile phone. In other words, it could be accessed and used (if and when an app is developed and distributed) with no additional equipment required by the reader.	Braille requires braille papers at the very least. These papers may be relatively inexpensive to produce, but they do require that one has access to the necessary equipment – or, at the very least, access to a support person or instructor with the necessary equipment. (Perkins Braillers in Canada are often available as donations to those in need, while braille printers that connect to computers tend to be quite a bit more expensive. In Canada, even these printers may be distributed to students with demonstrated need, but the same is not necessarily the case in other countries). For EAL learners who want to learn to read, the additional resource requirement poses another potential barrier.
Enjoyment (Agency of Education, 2022)	The use of tone, pitch, and configurations of musical instruments may lessen anxiety and even increase enjoyment around reading for beginner EAL learners.	Braille cells offer a more mathematical presentation of reading as six dots are rearranged in 26 different ways to make up the English alphabet. This may, at least in the case of some beginner EAL learners, make the task of learning to read more daunting.

The above comparisons between teaching OVAL and braille suggest that OVAL may lower the barriers to using some of the evidence-based strategies for teaching reading.

5. Discussion

5.1 Overview

The purpose of this study was to investigate OVAL as an auditory orthography as compared to braille for learning to read by preliterate EAL adult learners who have visual disabilities. Three questions were addressed:

1. How effectively will OVAL audemes be learned and retained by preliterate EAL adults who have visual disabilities?
2. What is the attitude and perspective of the participants towards the OVAL modality as compared to braille?
3. What are the observations of an instructor on teaching preliterate EAL adult learners who have visual disabilities to read using OVAL in comparison to braille?

5.2 Retention of OVAL Audemes

The current study assessed the retention of OVAL audemes among seven participants. A second part of the study compared the retention of OVAL audemes with the retention of braille letters among two participants.

5.2.1 Retention of OVAL Audemes Among 7 Participants

The rate of retention of the nine OVAL audemes was assessed on the same day the seven participants received two hours of training in OVAL. The results showed a 71.29% average level of accuracy in identifying the nine audemes among the seven participants. These results are lower than those identified in the initial OVAL study by the Hebrew University team, which yielded a 96.67% level of accuracy in audeme identification among 18 participants (Arbel et al., 2020). The differences in results could be accounted for in the following ways. Firstly, the participants in the Hebrew University team study were literate adults learning OVAL in their

first language, Hebrew (Arbel et al., 2020). None of them had diagnosed neurological conditions and all had normal or corrected-to-normal visual and hearing abilities (Arbel et al., 2020). In contrast, the participants in the current study were preliterate in that they had not learned to read and write at the typical development stage. Several of them had begun to learn to read and write braille only two years before, as young adults. In addition, all the participants in the current study were learning OVAL in a language other than their first. The current study also did not take into account the possible presence of neurological conditions, such as a learning disability, as well as hearing disabilities. Secondly, the difference in the number of training hours between the two studies might be suggested as a factor influencing the differences in results. While the current study provided two hours of training on nine OVAL audemes, the study by the Hebrew University team provided six hours of training on 11 OVAL audemes. It should be noted, however, that the training by the Hebrew University team included time for word/pseudo-words reading and 2-words combinations reading. In addition, the Hebrew University team identified that the majority of participants "learned 7–9 OVAL letters (and to read short words composed by them) within the first 2-hours training session, with some participants, from the 'Color' group even succeeding to learn all 11 OVAL characters within this first training session" (Arbel et al., 2020, p. 8). Therefore, it could be said that the difference in training times between the two studies is not a significant factor. Thirdly, the audemes that were learned by the two groups might have shaped the outcomes to a certain extent. While the current study tasked participants with learning the following letters of the English alphabet, p, e, a, i, o, u, r, d, s, the Arbel et al. (2020) study chose a mostly different set of letters of the Hebrew alphabet. As noted in the Findings section, participants in the current study showed a greater degree of error with at least two letters that sounded similar to one another, p and d. In contrast, the study by the Hebrew

University team noted no pattern of errors in the same version of OVAL as that used by this study (Arbel et al., 2020). Taking into account all of the above factors, the 71.29% average may be considered to support the conclusion of the Arbel et al. (2020) study that "the OVAL auditory-reading script can be successfully learned in adulthood, after a relatively short specific training" (p. 15). That is, while the accuracy average for the audeme identification task was lower for the current study than that achieved in the initial OVAL study by the Hebrew University team, it is still worth noting given the real and potential factors and barriers facing the participants in the current study, including that learning took place remotely via smartphones/personal devices.

No comparable studies on the average length of time it takes to learn a certain number of braille letters were found, including the time it takes for a preliterate EAL adult to learn a certain number of braille letters. Several studies explore the experience of learning braille as an adult, either an adult with acquired visual disabilities (Martiniello et al., 2022) or as a sighted adult (Bola et al., 2016). While the studies note that learning braille as an adult took participants several months (Martiniello et al., 2022; Bola et al., 2016), they do not provide detail on the number of hours of training required to learn and retain a certain number of braille letters. Future research could investigate the retention rate of a certain number of braille letters among adults learning braille for the first time, more specifically EAL adults with visual disabilities.

5.2.2 Retention of OVAL Audemes as Compared to Braille Letter Retention Among 2 Participants

The two participants who were tested in both braille and OVAL showed a remarkable difference in results. While both participants scored 100% in recalling the OVAL audemes, their braille scores were lower, with an average of 44.50% between them. Between the two participants, one

achieved a score of 22.22%, while the other scored higher at 77.78%. These participants have received approximately 150 hours of training in braille since 2019, although much of that training has been challenged and interrupted due to the pandemic. For months at a time, they received online braille training, which poses significant barriers, particularly for an EAL adult just beginning to learn English. Regardless, they have spent more time training in braille than OVAL yet demonstrated a higher recall level with the auditory orthography. The differences in retention could be accounted for in the following ways. Firstly, although formal testing would be required to corroborate this, my observations as an instructor suggest that at least one of the participants may lack a certain amount of tactile sensitivity, which makes differentiating the braille letters very difficult. Tactile sensitivity is integral to braille reading, and while it can improve with exposure and practice (Martiniello & Wittich, 2022) these participants had only begun learning it less than two years before, much of it online, which did not allow for the same level of practice. Secondly, it could be argued that the braille letters that were assessed are similar enough to generate mix-ups. As with all orthographies, braille includes several letters that tend to be confused more often due to their similar features. These letters include: e and i; w and r; d and f. A consideration of the results of this study shows that e and i were indeed incorrectly identified by both participants. However, the OVAL audemes that were assessed also include a number that are similar in sound, including p and d. Thus, the similarity between braille letters cannot be considered a significant factor shaping the difference in retention results between the two orthographies. Thirdly, the state of the participants following the OVAL training may have been a contributing factor in their recall. Heightened attention due to the recent energizing experience of learning with acquaintances from six different countries may have generated a stronger focus during the OVAL assessment than during the braille assessment, which was

conducted on a different day and time, and not following a group learning experience. This would correspond with studies showing that working in a group may facilitate learning academic knowledge (Hammar Chiriac, 2014). Most of the participants in the OVAL study knew of one another, with several describing themselves as acquaintances or even friends. That, combined with their shared experiences as people with visual disabilities, could have created the sense of "affiliation, fellowship, and welfare" that Hammar Chiriac (2014) identifies as "highly important" in group learning, noting these qualities "may even be essential prerequisites for learning" (p. 8). Considering all of the discussed factors, it may be possible to attribute the difference in results to the orthographies, but further research is required. Research involving a greater number of participants could ascertain whether the results experienced with these participants are replicated. It could also be beneficial to assess participants' retention of the OVAL audemes over time, as compared to braille. Is there a higher retention of a tactile orthography over time as compared to the auditory orthography?

5.3 Attitude and Perspectives on OVAL versus Braille

5.3.1 Survey Responses

The current study investigated the attitude and perspectives of seven participants on OVAL as compared to braille. A Likert-scale survey asked participants how much they liked learning OVAL as compared to braille, as well as which they preferred more, the thought of using OVAL in the future, or braille. While the participants had a similar rate of response to the experience of learning OVAL audemes as compared to braille letters, in that they were either neutral, somewhat liked it, or very much liked it, a higher percentage said they liked the experience of learning braille words more than the experience of learning the OVAL blends. These results may be accounted for in the following way. The fact that the participants seemed to equally enjoy

learning OVAL audemes and braille letters but diverged in their preferences with respect to learning OVAL blends and braille words may be partly due to the nature of the OVAL training. That is, the focus on blends as opposed to recognizable words (although a few were spontaneously included during the training) may have contributed to the reduced enjoyment of the OVAL blends portion of the training. As the principles of adult learning show, adults tend to be keen to know the relevance of whatever training it is that they are undergoing to their everyday lives (Finn, 2011). Focusing on blends, which may also be referred to as syllables or pseudo-words, while identified in the literature as a promising strategy for adult literacy learners (Moore, 2002) may have been a less effective strategy with this group, especially given that while they are preliterate, they do have knowledge of how to read. While only including blends was intentional in this study in that the OVAL training was based on the adult literacy program by Moore (2002), future research, particularly if it engages participants of a similar demographic as that included in this study, may want to consider replacing or adding to the blends portion of the training a focus on words training. With regards to the question about thinking about using either braille or OVAL to read in the future, the same percentage were neutral, but a higher percentage "very much liked" the thought of using braille to read in the future, as compared to OVAL. The interview portion of this study provides further insights from the participants on the reasons for their responses to the survey questions, including the noted preference for using braille to read in the future.

Most of the Spearman tests did not show a significant correlation between the various survey responses and either the OVAL assessment levels or braille levels. However, one Spearman test demonstrated a significant and positive correlation between OVAL level and interest in using OVAL in the future. That is, those with a higher the level of success in recalling the OVAL

audemes also tended to show a greater interest in future OVAL use. This is noteworthy for future studies and potential training in OVAL. Researchers and trainers will want to consider how they can set up the OVAL training to ensure a certain level of success, as this may correlate to an increased interest in using OVAL thereafter. This finding corresponds with research on the implications of success for generating additional success (Iso-Ahola & Dotson, 2014).

5.3.2 Interview Responses

A qualitative analysis of the participant responses to the interview questions yielded four themes that also arose in the literature: accessibility, ease of learning, reading by decoding, and ease of use. Firstly, participants in the current study noted the importance of being able to access an orthography, such as OVAL, with several highlighting the benefits of its online accessibility. This finding corresponds to the literature on access to braille equipment and materials, with several noting the challenges with braille learning and use in some countries and circumstances, such as the pandemic, due to the lack of access to equipment and materials (Kalra et al., 2009; Saifullah, 2021; AFB, 2022; Rosenblum et al., 2020). Secondly, participants referred to the importance of easily learning an orthography, noting the challenges they experienced with learning OVAL, which some identified as being due to the similarities between several audemes. This theme of ease of learning also corresponds with the literature on the ease (or lack thereof) in learning braille, including as an adult (Martiniello et al., 2022), which in some cases may be due to a lack of tactile sensitivity (Martiniello & Wittich, 2022). Other studies highlight the lack of qualified teachers as a barrier to easily learning braille (Argyropoulos et al, 2019; Kalra et al., 2009). One author has even gone so far as to suggest that braille could become obsolete if a way is not identified for it to be self-taught (Carey, 2016). Thirdly, all but one of the participants identified the importance of being able to read by decoding. This also corresponds with the

literature, where several studies show participants who have visual disabilities noting the importance of knowing how to read by decoding or braille (Argyropoulos et al, 2019; Marshall & Moys, 2020; D'Andrea, 2012). In contrast, however, even as participants in both this study and the literature identify the importance of reading by decoding, the majority make use of tools such as screen readers, which do not require reading by decoding, in order to complete at least some tasks in their daily lives (Argyropoulos et al, 2019; Marshall & Moys, 2020; D'Andrea, 2012). The literature and participants in this study note varying reasons for this, with ease of use being one theme (Argyropoulos et al, 2019; Marshall & Moys, 2020; D'Andrea, 2012). As one participant in the current study noted, "Certainly, I do not read (braille) because there is a technology complete with all of our requirements." Another one pointed out that it is "much easier to read a paragraph with a screen reader than reading it by processing, I mean braille or OVAL." Similarly, in the literature, study participants noted they believed they achieved their best performance through listening to text being read to them as it was less tiring and time-consuming than reading braille or large print (Argyropoulos et al, 2019). In summary, the future acceptance of OVAL as a decoding option is likely to depend to a large extent on how well it meets the considerations mentioned above, notably accessibility, ease of learning, and ease of use.

Three additional themes arose in the current study that are less frequently noted in the literature, if at all, but are worth pointing out: expanded opportunities, the sensory experience of reading, and interest in future OVAL use. Firstly, several participants mentioned that learning OVAL could provide them with an additional skill that could expand employment and/or volunteer opportunities for them. Specifically, they mentioned learning it well enough to teach others. Given that the employment rate of people with visual disabilities tends to be significantly

lower than that of the sighted population (CNIB, 2018), this is noteworthy. While they could certainly teach braille as well, the participants seemed to note aspects of OVAL, including perhaps its newness and online accessibility, that could also give them an edge in terms of employability and/or a way to give back to the community. Secondly, several participants referred to the differences in the sensory experiences that braille and OVAL provide. One participant noted he sometimes gets tired of feeling braille dots, and he liked the idea of having the option of reading by decoding through listening to OVAL. Other participants mentioned preferring one sensory experience over the other with respect to their reading. This point is worth mentioning as those who are sighted typically would not think much about the act of reading as a sensory experience. For people who have visual disabilities, it is more clearly so. Providing options for them that take into account the sensory factor, in addition to accessibility, ease of use, and ease of learning, is important. Finally, the current study noted the level of interest in future OVAL use. While there were mixed responses in the survey and interviews in terms of participants liking the idea of using braille versus OVAL in the future, the majority did say they would learn and use OVAL if the developers create an app. A higher percentage, however, said they liked the idea of reading in braille in the future more than the idea of reading in OVAL. Part of the hesitance around OVAL may be attributable to the fact that it is an innovation and, as with all innovations, there can be mixed responses. As author Everett Rogers (2003) notes, diffusion of innovation is a kind of social change and, depending to some extent on the social structure in which an innovation has been introduced, that diffusion may face barriers. That said, however, the innovation itself will also determine its likelihood and rate of diffusion (Rogers, 2003). It is noteworthy that the majority of participants, while preferring the idea of reading in braille in the future, were also open to learning and using OVAL if the developers create an app. This also

corresponds with Rogers' (2003) theory on the diffusion of innovations, notably that an innovation that can be "tried" more easily is more likely to adopted than one which cannot be easily experimented with. In summary, this study identified that OVAL may expand opportunities and sensory reading options for people who have visual disabilities, but the nature of its diffusion as an innovation within the community of those who have visual disabilities and those who support them will depend on both the community itself and the inherent characteristics of OVAL as innovation, including its trialability.

5.4 Instructor Observations on the Affordances of OVAL and Braille

The current study considers the affordances of OVAL and braille with respect to teaching preliterate, EAL adults who have visual disabilities. While the findings may be generalizable to other populations, future research is needed to corroborate this. For the identified population, OVAL as an orthography holds potential for meeting the following criteria and considerations of a program for learning to read: shared reading, peer support, repetition, remote learning, accommodations, access to equipment and materials, and enjoyment (Mitchell, 2018; Bethel, 2017; Ghazi-Saidi & Ansaldo, 2017; MacKenzie, 2021; Young et al., 2019; Martiniello, 2022). While a reading program in braille could be said to also meet these criteria and considerations, teaching in braille includes several factors that may pose a barrier or at the very least an added challenge for the studied population: the inherent limitations of an orthography based on touch; and the nature of the equipment and materials required. Firstly, a tactile orthography, by definition, offers a different student-teacher and peer-to-peer experience with respect to learning to read. Interactions around the reading material centre on a physical space, that is, the raised dots known as braille, whether that is on paper or a refreshable braille display. While this becomes less of a consideration with more advanced braille readers, for beginners, and especially

for beginners who are also learning English as an additional language, it can pose an added challenge. For example, when peers are providing support to one another in the classroom, they must have a way of confirming they are referring to the same braille cell. These might involve calling out the numbers of the braille cell or moving a peer's hand to check. In a classroom where students are beginning to learn English, calling out the numbers will not be as straightforward as in a classroom where students are more advanced in the English language. Conducting these checks online comes with its own set of unique challenges, again, particularly for beginner EAL adult students who have visual disabilities. While these checks may not be considered onerous necessarily, they do add a component to the learning experience that, for instance, the auditory orthography does not include. Secondly, braille requires access to braille content, which may be in the form of papers, books, or refreshable braille displays. Research is also ongoing around providing braille content to read via mobile devices, which is promising. However, in the case of a number of apps that are now available, such as KNFB Reader and the iPhone's built-in braille feature, a refreshable braille display must be connected in order to read. This is an added equipment requirement. Apps for inputting or writing braille on a mobile device are more common than those for reading braille on a mobile device, although a touch screen that rises and falls into appropriate braille cells as one reads is in development (Atherton, 2016). Again, accessing the braille content and equipment may not necessarily be onerous, especially in some countries and circumstances, but it is a component of the learning experience that must be addressed. OVAL as an auditory orthography also requires access, namely to a computer or mobile phone that has the OVAL program or app installed. This access may also be limited in some places and circumstances, but it does not include the need for a specialized touch screen such as the one currently in development for reading braille, or an additional display device such

as that required by the iPhone braille reading feature. Finally, the instructor observations include a reflection on the possibility that an auditory orthography such as OVAL may be enjoyable to learn given the use of tone, pitch and configuration of musical instruments. This is only speculation, and further research would be required to confirm, but it is worth noting that research shows that those who enjoy the reading experience tend to do more of it (Vermont Agency of Education, 2022). In summary, both OVAL and braille meet the identified criteria and considerations of beginner reader programs for preliterate, EAL adults who have visual disabilities, with OVAL as an auditory orthography holding the potential to reduce some barriers and challenges inherent in a tactile orthography.

5.5 Educational Implications

While further development of OVAL as an auditory orthography is still required, it could eventually hold potential as a tool for teaching reading to anyone who has a visual disability, but, especially, based on the current study, those facing a complexity of factors, such as being preliterate and/or learning to read in a language other than their first. It is also noteworthy that people from around the world could potentially join classes, as long as they had a computer or mobile device with the program or app installed. The implications for expanding the opportunities to learn to read by decoding as people who have visual disabilities cannot be overlooked. Even while braille continues to be, and, no doubt, will always be the primary reading-by-decoding system for people with visual disabilities, offering another easy-to-access, potentially fairly easy-to-learn, low-cost option for reading by decoding should be considered a matter of social justice and highly championed by all proponents of equity in education.

5.6 Limitations and Future Research

The current study used three types of data collection, assessment results, Likert survey, and

interviews. While the assessment results were as reliable as they could be given the use of online learning rather than face-to-face due to the pandemic, future research could test for a difference in results with a similar population undergoing the training and assessment in the same physical space, as opposed to over video-conference. The OVAL assessments could also be more extensive than those undertaken in the current study. Future research could test not only accurate retention of the OVAL audemes, but also speed. The assessment could be expanded to include the reading of whole words in OVAL.

In addition, while two of the current study's participants were able to be tested in braille, the others were not due to challenges with conducting assessments in braille virtually as five of the seven were from six different countries. While virtual braille assessment is possible with students who have access to a local teacher who can provide support in conducting the assessments locally, in this study, all the participants were adults and none of them were currently taking braille classes. The majority of the participants were from countries where less braille support, including in the form of equipment, is available, so they did not have access to braille printers. Future research would ideally compare the rate of accuracy and speed in reading OVAL audemes and words with that of the rate of accuracy and speed in reading braille. Nonetheless, the very fact that this limitation exists in terms of the challenges of assessing braille virtually speaks to the importance of making available alternative reading-by-decoding systems for people who have visual disabilities.

With respect to participants' self-reporting of their braille levels, the current study relied on the participants' level of self-awareness and judgement. The responses ranged from beginner to advanced, with several participants citing reasons for their choices, including length of time learning braille and rate of reading speed. However, future studies could provide some

parameters around the self-reporting, which could make the task a little easier for the participants while ensuring a more standardized response.

With respect to the surveys and interviews, the fact that the participants were responding in a language other than their first may have contributed to some misinterpretation. The potential of this happening was intended to be mitigated by having a translator available, but meaning can shift from one language to another, and there is a chance that the exact expression of a participant's answers may have been slightly compromised in some instances. In addition, even with more advanced EAL speakers, the possibility of some misinterpretation of their exact meaning exists. While this may be less of a concern in a study like this, which was intended to get a sense of participants' attitude and perspectives towards OVAL as compared to braille, it is certainly a source of potential imprecision to keep in mind.

The small sample size for the current study is another limitation, although the study's specialized target population – preliterate, EAL adults who have visual disabilities – necessarily reduced the number of potential participants. Future studies of OVAL could parse out the required characteristics of the target population, thereby potentially expanding the group of potential participants. For instance, one study could focus on preliterate adults who have visual disabilities, another on EAL adults who have visual disabilities, and still another on children who have visual disabilities. Given the small sample size of the current study, the generalizability of the findings is potentially reduced. That said, the fact that the potential in OVAL was noted in such a specialized group may in fact mean it holds even more potential in groups and contexts not addressed in this study. For instance, the study showed the participants, as preliterate, EAL adults, retaining knowledge of the OVAL audemes after only a short training period at what would be considered a "B" average level. One could conjecture that the retention rate could be

even higher in other population groups, for instance, among children. In fact, as already noted in this paper, the initial study on OVAL by Arbel et al. (2020) shows a higher retention rate among literate adults learning OVAL in their first language.

6. Conclusion

The importance of improving literacy rates worldwide, including for those who have visual disabilities, cannot be overstated. While making room for a widened definition of literacy is critical, as explained in this paper, providing options for people to learn to read and write by processing symbols is still valuable. People may choose not to access those alternatives, but it is a matter of social justice that the options be made available. For those who have visual disabilities, the choices for reading by processing symbols are evolving. While to date these evolved options with respect to reading by decoding have largely concentrated on making braille available in technological forms, the recent introduction of a new auditory orthography, OVAL, by the Hebrew University of Jerusalem is worth consideration and further research. The current study investigated the affordances of OVAL as compared to braille within the context of a very specialized population – preliterate EAL adults who have visual disabilities. The results suggest that at the very least OVAL should continue to be developed and researched, with input from the community of people who have visual disabilities. Ultimately, consideration could be given to offering it as an alternative and/or supplementary orthography for all people who have visual disabilities but perhaps especially those who face added barriers, such as those who are preliterate and/or who are learning to read and write in a language other than their first. If literacy is indeed a "means for development and not just an end in itself" (UNESCO, 2021, para. 11) as well as a key contributor to the "liberation" of people (UNESCO, 2021, para. 9), then doing whatever we can to move it forward is much more than just a good idea. It is a matter of advancing a human right.

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Appendix A

Information Form to Participate in a Comparative Study of Tactile Versus Auditory Orthography for Teaching Reading to English as an Additional Language, Preliterate Adults who have a Visual Disability

My name is Michelle Strutzenberger. I am a student at Ontario Tech University. I am doing a thesis on braille and how it compares to a new way for people who are blind to read called OVAL. I am doing this research for my Master of Arts in Education. I have a supervisor whose name is Dr. Allyson Eamer. She is the principal investigator for this research. If you want more information about this study, you can contact my supervisor at Allyson.eamer@ontariotechu.ca. You can also contact Ontario Tech University's research office if you have questions about the ethics of this study. The phone number is (905) 721-8668 ext. 3693. Or, you can email researchethics@uoit.ca. If you have more questions after listening to this letter, you can contact me at michelle.strutzenberger@ontariotechu.net. This study has been approved by the Ontario Tech University and Fleming College Research Ethics Boards.

Introduction

Note: This consent form will be read in English and translated into the participants' first language; the potential participants are English as an Additional Language learners. The translator will be present during the reading so the potential participants can ask questions. This letter will also be provided as an audio recording in the participants' first language so that the participants can listen again later in order to ensure understanding. The potential participants will be informed that the translator will be present for the interviews as well. They will be told that the translator has signed a confidentiality form.

You are being invited to take part in a research study about learning to read using braille versus learning to read using another new system called OVAL.

This form will tell you about the study, how it will work, what is good about it and what may not be good.

You do not have to take part. It is up to you. If you don't take part, that is okay. But if you want to take part, you can.

You should take as much time as you need to make your decision about whether you will take part.

You should ask the Principal Investigator (PI), whose name is Dr. Allyson Eamer, or the study lead, whose name is Michelle Strutzenberger, to explain anything that you do not understand and make sure that all of your questions have been answered before signing this consent form.

Before you make your decision, talk about this study with anyone you wish including your friends and family.

It is up to you if you want to take part. You do not have to.

This study is separate from the English course you are taking at Fleming. It does not have any impact on the course you are taking at Fleming. Nothing about the course you are taking at Fleming will change if you do this study.

I need to give you all the information about the study upfront so you can decide whether or not you will participate.

For the study, you will spend 2-4 hours learning this new way to read called OVAL. You will then do a short assessment and answer some questions on a survey and in an interview. The assessment, survey, and interview will take about 2 extra hours.

The study will be done in person, following all Covid protocols.

Further down on this paper, you will learn about the benefits of doing this study, as well as

the risks.

If you don't want to do this study, you don't have to. It will not affect your other coursework at Fleming, your grades, or your relationship with your instructor in any way.

If you don't want to participate, you don't have to do anything.

If you want to participate, you need to tell the researcher that you want to do and say you agree to do it by (insert date). You can send a voice message to say you want to participate.

Purpose and Procedure:

Purpose:

People who are blind have to learn to read using different systems than people who are sighted. Many people who are blind learn to read using braille. But braille is not the only system to use. A research team has developed a different system that involves listening to special sounds that represent the letters of the English alphabet. It is a way to read by listening. The system is called OVAL. The research team has done some studies and their research shows OVAL is easy to learn.

The purpose of this study is to research how OVAL works for adults who are learning English and who may not have learned to read and write in their own language.

You have been invited to participate in this study because you are learning English as a second language, you may not have learned to read and write in your own language and you are blind. You have been learning braille for a while, and now the past few weeks you have been learning OVAL. Now that you have learned some letters in OVAL, we want you to tell us what you think of learning to read using OVAL as compared to learning to read using braille. We also want to ask you if it is okay if we use your assessment results in the study.

Procedures:

The amount of time it will take:

The study includes: two to four hours to do the training, plus one to two hours to do the assessment, survey and interview.

What you will need to do:

For the study, you will first learn 9 letters of the English alphabet in Oval. You will take about two to four hours to learn the letters. You will then do an assessment, complete a survey and an interview. The assessment will take about 10 minutes. It will measure how many of the letters you can identify in OVAL. The survey will take about 15 minutes in total. The survey will ask you what you think about OVAL as compared to braille. The questions will be in English. The questions will be easy to understand. Your answers will be marked in a file on a password-protected computer.

The interview will take about one hour in total. The interview will let you say more about what you think about braille and OVAL. The questions will be read to you in English and your answers will be recorded as well as transcribed in a computer file on a password-protected computer. An interpreter will be present to support translation as necessary. The translator will have signed a confidentiality agreement.

The research information:

You will say what you thought about learning to read using OVAL versus using braille. We will use your answers to help decide if it is a good idea for others to learn OVAL too. We will also talk about the results of your assessments in OVAL and braille.

Who and where:

There will be four or more research participants in total. The research will take place at Fleming College or at your house or online. It will follow all the Covid protocols.

Potential Benefits:

There may be no direct benefits to you. The good thing about taking part in this study is that you will have a chance to contribute to research on reading systems for people who are blind. You will be able to say what you think about the new reading system. Your answers will help researchers decide if they should use this reading system with others.

Potential Risk or Discomforts:

If you decide to participate in this study, the difficult thing about participating in this study is that you will need to be clear about what you think about OVAL and braille. Maybe it will be hard to say what you think in English. In that case, we will have a translator present to help with translation. Also, if you decide to participate, you will need to give up about 4-6 hours of your time. We will take lots of breaks.

Use and Storage of Data:

All of the information from the study will be kept on a password-protected computer in the researcher's home. The information will include: that you are learning English as a Second Language, you are blind, you are an adult, and that you did not learn to read and write in your first language. The information will NOT include: your names, your gender, where you live, where you are from, your ages, or anything about your family. The researcher (Michelle Strutzenberger) and the PI (Allyson Eamer) will be able to read the information. The translator will hear the information that you say during the consent process and during the interviews. No one else will be able to read the information. No one else will know you have done the study,

except if you tell them. The information will be kept on a password-protected computer in the researcher's home. The information will be analyzed for the thesis paper that the researcher will write. It will be destroyed once the thesis paper has been written and presented.

The information will be used in the paper that the researcher writes.

Confidentiality:

Privacy and confidentiality mean that your personal, private information will not be shared with other people through this study. Only the results of your assessments and your answers will be shared, but people will not know it is you unless you tell them. Your names will not be shared in the paper that the researcher writes or when she presents. The other person who is doing the training and answering the questions with you will know that you have done the study. If you don't want people to know that you did this study, that is okay. If you are okay with people knowing that you did this study, you can let us know. It is up to you.

Voluntary Participation:

It is up to you if you want to participate in this study. You can decide not to be in this study. Or, you can say, "yes" and then say "no" later. That is okay. Even if you stop the study, you will still be able to learn English at Fleming College (for the two participants who are doing so). You can stop anytime you want to.

Right to Withdraw:

If you stop doing the study at any time, that is okay. The information we have gathered so far will be removed. You don't need to give any reason for stopping.

Conflict of Interest:

The researcher wants to do this study, but you do not have to take part if you don't want to. It is up to you.

Compensation, Reimbursement, Incentives:

You will receive a $25 gift card as a gift for taking part in this study. If you start the study and then stop partway through, you will still get half the amount. If you complete the study, you will get the full amount.

Debriefing and Dissemination of Results:

The results of this study will be put into a paper that the researcher, Michelle Strutzenberger, is writing about OVAL and braille. The paper will say what you thought about the systems, and it will talk about the results of the reading assessments. If you would like to know what the paper says, you can ask and we will let you know. The researcher can give you a taped presentation of the paper that you can listen to. The paper will not say: your name, your gender where you live, where you are from, your age, or anything about your family.

Participant Rights and Concerns:

Please listen carefully to all of this information in this consent form. You can call a place called the Research Ethics Office if you have questions or you are worried. The phone number is (905) 721-8668 ext. 3693. Or, you can email researchethics@uoit.ca.You can also talk to the researcher, Michelle Strutzenberger. Her phone number is (705) 761-8316. Or, you can email michelle.strutzenberger@ontariotechu.net. Even if you agree to this study, you still have your legal rights. Also, the researcher and the organizations she is working with, Ontario Tech University and Fleming College, still have their legal and professional responsibilities.

Consent to Participate:

You can tell the researcher (Michelle Strutzenberger) that you consent to participate. You can say, “I agree to participate in this research. I understand it will take about six hours. I understand the information will be used in a research paper, but my personal information will not be included. People will not know that it is me.” You can say this in the conversation about the study. You can also send a voice message saying, “I agree to participate in this research by Michelle Strutzenberger.”

If you do the training online, in your consent, you also need to agree that you will follow all the Covid protocols while you are on the Fleming College campus. Just as you do when you come to the college for your classes, you will need to wear your mask, sanitize your hands, scan your One Card, do the Fleming screening, and social distance. You need to say you agree to do this.

Appendix B

Thank You Letter

Dear (insert name)

Thank you so much for taking the time to participate in this study. You have helped me very much. You have helped other people who are trying to find other systems that allow people who are blind to read.

We will be giving you a small gift to thank you for your help.

Thank you so much (in their mother tongue).

Michelle Strutzenberger

Appendix C

Interview Questions

The questions for the participants are intentionally simple in language. The questions will be posed verbally. The participants will answer verbally. Their answers will be recorded in writing and using a voice recorder. A translator will be on hand to help participants express their answers more fully than their grasp of the English language may allow. The interview will be semi-structured in nature, with several questions to guide the discussion, but with opportunities for a fluid conversation that does not restrict the participant's self-expression when describing their literacy learning experiences.

Before beginning the interview, the following preamble will be given:

Thank you so much for your help and for taking the time to say what you think about these systems. Remember that we have a translator if you want help with any words when you are saying your answers. Also remember that you can take your time. You can go slowly, and if you want to stop and not answer, that is okay too. I want you to know that I will be writing down your answers and I will be recording them, but I will not be using your name, any information about your family, your address, where you live and where you are from. I will only be saying that you are learning English as a second language, that you are blind, and that you did not learn to read and write in your own first language at the typical development stage. Here is the first question. There are seven questions. You can take as much time as you want to answer.

1. Which did you find harder to learn, OVAL or braille? Explain.
2. Do you still read in braille?
3. How much do you read in braille now?

4. If you read in braille, what is it mostly for? School, work, pleasure, other.

5. How important is it to you to be able to read in English by processing symbols?

6. Do you think you would read more than you do now if you learned to read English using OVAL? Explain.

7. Would you learn and use OVAL if the developers create an app?

Appendix D

Likert Scale-Based Survey

Given that English is an additional language for the participants, the survey was intentionally clear and simple in phrasing, both with respect to the anchor points and items.

Anchor 1: I don’t like it at all.

Anchor 2: I don’t like it.

Anchor 3: I don’t like or dislike it.

Anchor 4: I like it.

Anchor 5: I like it very much.

Item 1: In the OVAL training, learning which OVAL sound is which letter.

Item 2: In the OVAL reading program, learning to read whole words.

Item 3: In the Braille training, learning which Braille sign is which letter.

Item 4: In the Braille reading program, learning to read whole words.

Item 5: Thinking of using OVAL to read in the future.

Item 6: Thinking of using Braille to read in the future.

Appendix E

OVAL Training Sequence

The following letters were taught to the research participants in the identified order: p, a, e, i, o, u, r, d, s. In the first portion of the training, the participants learned p and the five vowels. They then practiced listening to the blends of the consonant p and the different vowels. See the first chart below. Following a short break, the participants learned the remaining consonants: r, d, and s. They then practiced listening to the blends of the consonants and vowels as noted in the remaining two charts. This training process follows the program outlined by Moore (2002) for adult literacy learners who face additional barriers in learning to read, such as learning disabilities or who are learning to read in a language other than their first.

Letter p and vowels:

pa	po	Ap	op
pe	pu	Ep	up
pi		Ip	

Letter r, d, and vowels:

ra	dra	Ar	dar
re	dre	Er	der

ri	dri	Ir	dir
ro	dro	Or	dor
ru	dru	Ur	dur

Letter p, s, and vowels:

pa	spa	Ap	sap
pe	spe	Ep	sep
pi	spi	Ip	sip
po	spo	Op	sop
pu	spu	Up	sup

Appendix F

Audio Files of the Nine Audemes and Three Sample Blends

Audeme Name	Audio File
P audeme	P audeme.m4a
E audeme	E audeme.m4a
A audeme	A audeme.m4a
I audeme	I audeme.m4a
O audeme	O audeme.m4a
U audeme	U audeme.m4a
R audeme	R audeme.m4a

D audeme	D audeme (1).m4a
S audeme	S audeme.m4a
PA audeme blend	PA audeme blend.m4a
DIR audeme blend	DIR audeme blend.m4a
SIP audeme blend	SIP audeme blend.m4a

Appendix G

Selective Codes Used in Identifying Themes

Selective Codes	Themes
accessibility of OVAL; benefits of OVAL; access to braille; remote learning; braille versus technology	Accessibility
new skill; extra learning; alternative to braille; teaching and helping others	Expanded opportunities
speed in braille; braille versus technology; deficits within OVAL; letters versus syllables/sentences; why learn another system;	Ease of learning
Listening to someone read to you; hearing versus touching	Sensory experience of reading
benefits of reading by processing symbols; braille versus technology; current braille usage	Reading by decoding
likelihood of reading more; level of confidence in braille	Ease of use
OVAL app use; accessibility of OVAL; replacement versus extra tool	Interest in future OVAL use