Learning to Read without Sound: Literacy Across Deaf Populations

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Contents
0. Abstract ............................................................................................................................... 2
1. Introduction ......................................................................................................................... 3
2. L1 Acquisition ..................................................................................................................... 8
   2.1. Acquisition of oral language by deaf children (Yoshinaga-Itano & Sedey, 1998) ....... 9
   2.2. The importance of Age of Acquisition (AoA) .......................................................... 12
   2.3. Homesign and its relation to L1 acquisition ......................................................... 14
3. Techniques of literary acquisition ...................................................................................... 16
4. Shared reading ................................................................................................................... 17
5. Specific mechanisms in literacy ....................................................................................... 19
   5.1 Phonological knowledge ............................................................................................ 20
   5.2. Vocabulary knowledge ............................................................................................. 22
6. The effects of orthography on literacy ............................................................................ 25
   6.1. Kargin et al. (2012) ................................................................................................. 26
   6.2. Clark et al. (2016) ................................................................................................. 27
   6.3. Soundless writing systems: deaf literacy in China ................................................. 29
   6.4. Linking the ODT to phonological skills ............................................................... 32
7. Conclusion ......................................................................................................................... 33
8. References ......................................................................................................................... 34
Abstract

Multiple studies have shown that the best deaf readers are those who use sign language as their primary means of communication rather than an oral language. This thesis first seeks to answer the question of why this is the case. It is hypothesized that deaf signers are better readers because sign language is more easily acquired as a full first language by deaf children, and as such, deaf signers have the general linguistic skills necessary to acquire a written language. It is found that the orally-educated deaf have overall diminished language skills and, like deaf signers, are unable to access phonological representations of language when reading; as such, they are at a disadvantage when acquiring literacy through phonological means. After it is determined that early language access, which is best facilitated through the use of sign languages in deaf populations, is paramount in ensuring literacy skills, this thesis then seeks to determine how deaf readers translate their language skills into reading skills, using evidence primarily from the dual-route theory of reading (DRT). The DRT consists of two routes: a route based on auditory phonology and a route based on lexical knowledge. It is found that the second route is more important in deaf literacy than the first, which is consistent with what we know about how deaf readers use (or don’t use) phonological knowledge when reading.
1. Introduction

Without the relative mastery of spoken language, developing the ability to read— a skill which is most often taught using phonetic mapping and auditory cues— might seem impossible. Several studies have shown that spoken language ability is one of the most significant predictors of future reading ability: children who have better phonological, grammatical, and vocabulary skills are generally better readers as well (Snowling & Hulme, 2011). This has been the accepted discourse for decades: in order to teach a child how to read a written orthography which is related to the phonology of the language upon which it is based, that child needs to have a strong grasp of the sounds of their language. However, there is one population of readers that complicates this picture: deaf\(^1\) readers.

The outlook for deaf readers has not improved much in the last 20 years (Wauters et al., 2008). Those who are prelingually deaf— meaning those deaf individuals who have not acquired a language before becoming deaf, as in the case of those for whom deafness is congenital or acquired in the first few years of life— have consistently poor outlooks in terms of education. The majority of deaf adolescents have been shown to read at or around the same level as 9-year-old hearing students, a phenomenon which is often referred to as the ‘fourth-grade hurdle’, one most deaf students struggle to overcome (Wauters et al., 2008). Without a sufficient grasp on literacy, no student, deaf or hearing, can be expected to perform at their best ability in an education system which is inextricably tied to the written word.

The solution to the issue of poor deaf literacy might seem simple: if spoken language abilities are consistently connected with higher reading outcomes in hearing students, then improving spoken language abilities in deaf students must lead to higher reading outcomes in

\(^1\) This paper will use the term deaf inclusively to refer to any individual who has severe-to-profound hearing loss.
these populations as well. However, this is not the case. One of the most compelling factors which seems to increase literacy skills in deaf populations specifically is the use of signed rather than spoken language (Hermaans et al., 2008; Goldin-Meadow & Mayberry, 2001). This is in spite of the fact that reading is most commonly taught through the linking of individual symbols and the sounds they represent—sounds that deaf students who exclusively use sign language have no access to. Deaf signers’ skill in literacy is contradictory to deaf educational models which assume that the only way to ensure good reading skills in deaf students is to emphasize a primarily oral model of communication rather than a signed one. Known as oral training, traditionally, this model eschews the usage of sign language entirely in favour of attempting to teach deaf children an oral language through methods such as lipreading (Gleitman & Newport, 1995). At its best, this oralist model may improve educational outcomes for children who have mild-to-moderate hearing loss; however, at its worst, children who have higher degrees of hearing loss are left with diminished reading skills or even, in many cases, an incomplete grasp on expressive and receptive language as a whole (Gleitman & Newport, 1995).

There are many competing theories which attempt to explain why reading improves in deaf populations with higher proficiency in sign language. This thesis will explore three of them in particular: the first is known as the Linguistic Interdependence Hypothesis (LIH). This hypothesis, posited by Cummins in a 2006 paper which analyzes the link between first language (L1) and second language (L2) skills, states that superior skill in the L1 leads to better acquisition of the L2 (Scott & Hoffmeister, 2016). This means that the stronger a student’s grasp of their first language is, the easier time they will have when learning a second language. In the case of deaf readers, the ‘second language’ in question is a written language.
Historically, there is a strong correlation between early language exposure and the relative strength of a speaker’s grasp on their first language. This is a phenomenon not only seen in signers, but across modalities: “… regardless of the modality (gestural-visual or oral-aural), the role of early language exposure seems to be critical for achieving a higher L1 proficiency.” (Scott & Hoffmeister, 2016, p. 59) The idea that early language exposure may increase overall linguistic ability and thusly increase later reading ability in deaf children is known as the early language exposure hypothesis (Clark et al., 2016). Unfortunately, students who are exclusively orally trained often do not acquire fluency in a language at all, simply because they do not have the access to sound that is required to fully acquire oral language. The written word is not something that can be learned if one does not already have a native language, as written languages themselves are unable to be learned as first languages (Goldin-Meadow & Mayberry, 2001). Therefore, if deaf students are attempting to learn to read without having a good pre-existing framework through which they can understand the concept of reading and the vocabulary being taught, their difficulties with the task can be better explained.

The Linguistic Interdependence Hypothesis is only one theory which may offer insight into the question of literacy proficiency in deaf signers. Another is a theory which applies more broadly to readers from all language backgrounds and modalities; it is called the Dual-Route Theory (DRT). The DRT states that there are two cognitive routes through which reading is processed, a lexical route or a phonological route (Clark et al., 2016). The lexical route is what it used to read when one typically already knows a word and its corresponding string of letters or symbol and does not have to sound out the individual parts in order to decode the word into something that is recognized phonologically. This route requires pre-existing knowledge of vocabulary in order to follow- when faced with an unfamiliar word, someone who cannot decode
the letters into their corresponding sounds and read aloud the word for auditory recognition will likely be unable to read it on their own unless it is translated. The phonological route, however, is what is used when someone parses a word into its individual letters and strings the sounds each letter makes together. This is one of the most often used methods of teaching hearing children to read (Banich & Compton, 2018), but it sees limited use in profoundly deaf students due to the fact that they have limited access to the sounds of oral language which these written languages are generally based upon (Goldin-Meadow & Mayberry, 2001). This will be explored later in further detail.

Not all languages have writing systems- i.e., orthographies- which are based on sound. Some languages, both modern and historical, use logographic writing systems, which, simply put, have symbols which stand for whole words or concepts rather than singular sounds which have no meaning of their own and are only used to enable readers to learn to read new words out loud. The most well-known and prominent example of one of these orthographies is the Chinese character system. From a purely linguistic point of view, since the reading of Chinese characters does not require the phonological knowledge which deaf readers do not have access to, many of the problems encountered by deaf readers of languages which use a sound-based orthography may not be encountered\(^2\). The idea that some languages may be ‘easier’ for deaf students to read than others is known as the Orthographic Depth Theory (ODT). The ODT primarily deals with orthographies which are phoneme-based rather than character-based, as the term ‘orthographic depth’ refers to how reliably one letter or letter combination can be expected to produce one sound. For instance, while English has a relatively deep orthography, containing many words

\(^2\) It must be noted that the recommended educational methods used to teach deaf children vary widely from country to country; how this may affect data from deaf Chinese readers is not going to be explored in this thesis, as it is purely theoretical, but would be worth exploration in the future.
which are not spoken as they are written, German has a relatively shallow orthography. The Chinese character system, within this framework, would be described as having an opaque orthography because the symbols have no relation to their pronunciation.

In this thesis, I will examine the role of different linguistic theories—specifically, the Linguistic Interdependence Hypothesis, the dual-route theory of reading, and the orthographic depth theory of reading—and how they each may aid or hinder deaf acquisition of literacy. Ultimately, evidence from a variety of studies, including studies on orthographic depth, phonological knowledge in deaf populations, and the efficacy of spoken language training in the profoundly deaf, shows that orthographic depth has limited effect on deaf literacy, which is potentially further evidence for the hypothesis that deaf readers, who have been shown to have limited or no grasp on the rules of spoken phonology and to not utilize phonology while reading, are more heavily utilizing the lexical route of the DRT. However, ultimately, everything ties back to the LIH: the profoundly deaf who are not allowed sign language rarely develop the linguistic framework necessary to build knowledge in a second language.

In Section 2, I will show the difficulties of learning oral language for an individual with severe-to-profound hearing loss; I will also show the results of several studies which link signing ability in deaf readers to literacy while analyzing several alternate factors, such as whether or not this link can be explained by alternate traits of sign language, such as its nature as a visual medium, or whether it is best linked to the idea that sign language is simply the easiest first language for someone who cannot hear to acquire fully. In Section 3, I will further explain what the dual-route reading theory is and how it may allow deaf readers to acquire written language without access to phonology. In Section 4, I will provide an overview of the educational methods used to teach language—focusing on written language—to deaf children, including Cued Speech.
(CS) and signed forms of oral language, which differ from natural sign languages. In Section 5, I discuss shared reading—i.e., parents reading to pre-literate children—and how it relates to the DRT and its efficacy in deaf children. Section 5 is dedicated to shared reading, or the act of parents reading stories with pre-literate and sometimes pre-lingual children, in deaf children of deaf parents; shared reading provides a stronger linguistic framework for all children and often gives them the tools to recognize words through the lexical route on their own. Finally, in Section 6, I will use the DRT to pose a question about how different types of orthographies, or writing systems, may be affecting the ease with which a deaf student can learn to read in a specific language.

2. L1 Acquisition

Chomsky posited that all human beings, regardless of factors such as intelligence, culture, or genetics, are born with a language-learning mechanism and have an innate ability to pick up on language (Pinker, 1994). Deaf children are no different. If children are given access to a language—even if that language isn’t directly spoken to them—they will learn that language and become fluent in it (Gleitman & Newport, 1995). Unfortunately, the vast majority of deaf children are not given access to language because they simply cannot hear oral language, and oral language is generally the only one they are exposed to. Lip-reading cannot be learned as a first language as it is not a true language form, and children who are exclusively ‘orally trained’ end up with, at best, a dearth of language-related struggles throughout life and, at worst, no native language at all (Gleitman & Newport, 1995).

According to the LIH, if deaf children cannot acquire speech well or fully, they will be at a significant disadvantage when attempting to learn a secondary communication system such as writing or an L2. In this section, I intend to provide evidence for the idea that oral training cannot replace sign language as a deaf child’s native language if that deaf child is both prelingually and
profoundly deaf. This has potential implications for the basis behind why deaf signers are better readers than orally educated deaf students if it can be shown that speech is not widely able to be acquired as an L1 in profoundly deaf populations.

Oralism, as previously defined, is the philosophy that deaf children are capable of learning full language through speechreading alone. At best, oral training is rooted in misinformation and an excessive- but understandable- desire by parents to want easy communication with their children. At worst, oralists believe that deafness is an intellectual disability that impairs a child’s ability to learn the only ‘true’ form of language- spoken language (Gleitman & Newport, 1995). While techniques such as lip-reading have their place in deaf education, oral philosophy’s fatal flaw is that it treats a community with diverse needs as a single unit whose members will all respond to the same methods of treatment and education. Hearing loss is measured along a spectrum, with the needs of children whose hearing loss is reported as mild being vastly different from those whose hearing loss is profound. Outcomes for children whose hearing loss is profound also vary greatly from case-to-case (Yoshinaga-Itano & Sedey, 1998).

2.1. Acquisition of oral language by deaf children (Yoshinaga-Itano & Sedey, 1998)

Evidence from multiple studies shows that even a small degree of hearing loss can have a profound impact upon a child’s ability to both acquire spoken language and produce the sounds of spoken language. Speech intelligibility varies widely across children with different categories of hearing loss; however, children with severe-to-profound hearing loss generally fare worse than their other hard-of-hearing peers. Even with hearing aids, the average intelligibility of children in this category is only 20% (Carney, 1986, cited from Yoshinaga-Itano & Sedey, 1998), with these children making significantly more consonant errors than their mild-to-
moderate hearing loss peers. Vowel errors are rarely reported in children with any degree of hearing loss, although they are more common in children who tend toward the profound end of the spectrum (Yoshinaga-Itano & Sedey, 1998).

Yoshinaga-Itano and Sedey (1998) dig deeper into the speech production abilities of children with hearing loss in a study which seeks to correlate intelligibility with several different factors, including degree of oral training, use of sign language, and overall linguistic skills. Their study is not a causal one- the outcomes find correlations only, which simply means that, while two factors may occur together, one does not necessarily cause the other, or vice versa. In this article, the results of two separate experiments are reported.

In the first, speech intelligibility was measured against several demographic and developmental variables. For our purposes, we will concentrate on the following: degree of hearing loss, mode of communication (i.e., whether oral communication or sign language was preferred), and expressive language ability. Intelligibility was measured through, among other things, the number of vowel types and consonant types reported in transcripts of the participants’ speech. No deaf-of-deaf children were reported out of the 147 total participants- all had hearing parents and were presumably not acquiring sign language, if sign language was the preferred mode of communication, directly from the familial unit. Degree of hearing loss was measured along a scale from mild to profound, with a small majority of participants (23%) in the profound category and 16% in the mild category. Of the participants, 35% were reported as using oral communication exclusively, with 65% using “some sign language.” (p. 187) Roughly half had had their hearing loss discovered after 6 months of age, and the vast majority of participants received home-based intervention from the same government-funded program.
The first study found that degree of hearing loss and mode of communication were negatively correlated with overall speech intelligibility – those with greater hearing loss reported were more difficult to understand, as were children whose primary mode of communication was sign language. The two groups often overlapped – sign language was reported as the child’s primary language more often in those identified as profoundly deaf than those whose hearing loss was mild or moderate. While these results may initially seem like a point in oralism’s favor, it is important to keep in mind that this is only true if the measure of success for a deaf person is their skill in spoken language rather than their relative skill in language at all – or, in other words, if a child who speaks poorly is valued over a child who signs well.

Expressive language ability was positively correlated with intelligibility in this study, although the cause of this is unclear: “... children whose expressive language skills are higher may have an advantage in acquiring speech, or it may be that better speech skills lead to better language skills” (Yoshinaga-Itano & Sedey, 1998, p. 194). However, this study fails to clarify whether expressive language skills were measured only in the speech condition and not in the signing condition. Perhaps if children whose primary mode of communication was sign were measured in their expressive language ability in that language rather than a spoken one to which they had limited or no access, the results may have differed. However, due to the fact that none of the participants had parents fluent in sign language, it is likely that the expressive ability of profoundly deaf signing children, even if measured in sign language, would have still been lesser than their mild-to-moderate hearing loss peers.

Only two profoundly deaf children were rated as having good speech intelligibility; both came from families which used speech as the primary mode of communication and were orally educated. However, the author sums up the meaning of these results well: “Clearly… the very
small number of profoundly deaf, orally educated children in this sample makes it difficult to draw any strong conclusions about the relationship of mode of communication and speech development…” (p. 208) However, the fact that such a small number of profoundly deaf children, regardless of mode of communication or educational style, had good speech intelligibility is telling in and of itself: although in every sample of the orally educated deaf, there may be those two exceptions, the majority of deaf children cannot be expected to acquire a language in a mode to which they have limited access. With limited speech skills, profoundly deaf children will be at a disadvantage when attempting to learn written language phonetically.

2.2. The importance of Age of Acquisition (AoA)

Yoshinaga-Itano and Sedey (1998) did not include AoA in the above analysis. However, many other studies have been done which have shown that sign proficiency correlates with the age at which a child was first exposed to sign— the older a child is at the time which they are first exposed to what will potentially become their first and native language, known as the Age of Acquisition (AoA), the less proficient they will be in that language compared to peers who whose AoA was earlier (Clark et al. 2016). Again, higher signing proficiency means that, within the framework of the LIH, the child will have stronger linguistic skills onto which they can map knowledge of an L2.

Unfortunately, the acquisition of sign language in our modern world is complicated by a variety of factors, the most important and difficult to overcome being the fact that the vast majority of deaf children are born to hearing parents. As Woolfe et al. (2010) says, “The majority of deaf children are not native signers; sign language exposure is typically late and inconsistent… [and is acquired from] hearing parents and professionals with often poorly developed sign language skills.” (p. 322) Clark et al. (2016) describes the majority of parents of deaf children as having only “beginner or survival” levels of proficiency in sign (p. 131). A child
cannot be expected to fully acquire a first language from those who do not have an adequate grasp over that language. Social factors also contribute to the relative lack of signing prevalence in deaf populations—hearing parents want, above all else, to be able to communicate with their children, something not easily done in a language that the parents do not know and must now learn (Rendel et al. 2018).

Despite these complications, earlier AoA repeatedly correlates with higher reading abilities in deaf students (Clark et al., 2016). For instance, it has been shown that deaf children of deaf parents who have little or no grasp on English tend to read at higher levels than deaf children born to non-deaf parents (Goldin-Meadow & Mayberry, 2001). According to the early language exposure hypothesis, this is likely because they have acquired sign language as their first language much earlier than deaf children whose parents do not have native proficiency in the language.

This thesis will not go into detail on the neurobiological reasons for why the early infant brain is best suited to the acquisition of language; however, it may be helpful to think of it as a piece of machinery which, while still technically working, gets harder and harder to use as time goes on (Pinker, 1994). The brain loses its plasticity, or its ability to change, and begins to become set in its ways as a child gets older. The brain assumes that if it receives no linguistic input, then language must not be something it needs to learn, and it will begin to neglect those regions which power language acquisition accordingly (Clark et al., 2016). This has been shown to be true in magnetic resonance imaging comparisons done between those deaf or hard-of-hearing individuals who were raised in signing homes versus those who acquired American Sign Language (ASL) as adults. Even though the second group had been signing for over 15 years at the time these studies were performed, it was only the first group that showed linguistic
activation similar to hearing MRI results (Clark et al., 2016). As Clark et al. (2016) states, it is clear that, “… delayed language acquisition impacts not only how deaf individuals’ brains process linguistic information but the structural development of cortical tissue.” (p. 130)

Within the study of the reading skills of deaf populations, the theory that improving basic language skills leads to the improvement of literacy is sometimes referred to as the early language access theory (Clark et al., 2016). This theory has widespread implications for language acquisition in deaf populations, and addressing it should be the first line of defense in preventing the academic and personal struggles that deaf and hard-of-hearing students and other individuals face throughout life.

2.3. **Homesign and its relation to L1 acquisition.**

The knowledge that language acquisition is an inborn ability in all human beings, as natural as breathing, is something well-known by linguists. However, little attention has been paid to the fact that all human beings are also born with the innate desire to communicate. Little else exemplifies this better than the phenomenon of self-generated communication systems created by children who are otherwise isolated from language, and few others exemplify those isolated from language than deaf and hard of hearing populations. Signed communication systems created by children to communicate with non-signing family members in a medium which is natural and accessible to them are known as homesign systems, as they are almost always unique to a particular child and their family (Gleitman & Newport, 1995). In extraordinary (or perhaps, all too normal) circumstances, these homesign systems have been known to develop into full languages when multiple homesign systems come together in environments such as schools for the deaf.

The most famous example of homesign systems accumulating and evolving into true language is the sign language known in English as Nicaraguan Sign Language. Nicaraguan Sign
Language is a naturally-evolved language which arose from a group of deaf students who were denied sign language in favour of an oralist educational model: "The schools focused on drilling the children in lip reading and speech, and as in every case where that is tried, the results were dismal." (Pinker, 1994, p. 36) The different homesign systems that these children brought with them from their home environments aggregated into a 'schoolsign' system, which the children used in order to communicate with each other (Pinker, 1994).

Nicaraguan Sign Language in fact consists of two signing systems: the first, abbreviated as LSN for the Spanish term Lenguaje de Signos Nicaraguense, is the highly symbolic, non-standardized form of the signing system used by the young adults who acquired the system around age 10, and ISN (Idioma de Signos Nicaraguense) is the pidgin form of the same language acquired by children as young as four from the adult LSN signers. ISN shares many of the same vocabulary and structural characteristics of LSN, but unlike LSN, it has a much more standardized grammar: "Their signing is more fluid and compact, and the gestures are more stylized and less like a pantomime." (Pinker, 1994, p. 36) The young signers of ISN took even the incomplete and discordant language input from their LSN-signing peers and formalized it with no training; their brains, like the brains of all human beings, were designed to do so. In the absence of a suitable alternative, these children created their own language.

Though homesign is often developed by any young children who lack access to a signed language, the situation of the Nicaraguan signers is unique: new languages can only be generated within a large group and not between only one or two people (Gleitman & Newport, 1995). Unfortunately, not all deaf children have access to such a community, and as such, situations such as this remain rare. However, this new language, which arose in an environment where children were orally trained, shows that deaf children will much more readily acquire a signed
language rather than a spoken one which they have severely limited access to, even when
techniques such as lip-reading are used.

3. Techniques of literary acquisition

Among all of the techniques that have been shown to improve literacy in deaf students,
aquisition of a visual-manual language is always at the core. Even techniques designed to aid in
oral language development in deaf students have a strong visual component to them: Cued
Speech, which was designed to aid in teaching oral language to deaf students, uses simple hand
motions around the face and mouth that correspond to different spoken phonemes (Rendel et al.
2018). Little research on the efficacy of Cued Speech both broadly and in terms of its effect on
literacy acquisition has been done, however. It cannot be said with absolutely accuracy whether
this can effectively allow deaf students to acquire language without the use of sign, but given
data from other areas of research on lipreading, it is not likely: Rendel (2018) explains this with a
quote from a 1990 book written by Gerilee Gustason: “Research on speechreading indicated that
40 to 60% of the sounds of English looked like other sounds on the lips (e.g., interest, interesting,
interests, and interested are nearly impossible to distinguish) and the best speechreaders used
their knowledge of English to fill in the gaps... otherwise bright and capable deaf children caught
only 5% of what was said though speechreading.” (p. 20) Of course, children who are
exclusively trained in lip-reading do not have a pre-existing knowledge of English with which
they can fill in the gaps, making speechreading ineffective as a source of L1 acquisition.

A better alternative to Cued Speech is signed oral languages. These are code-like systems
which directly translate words in an oral language into signs which do not always correspond to
their equivalents in natural sign language. These signed forms of oral languages are not
translations of oral languages into another language, but rather transliterations (Rendel et al.,
2018). However, once again, these systems are not the cure-alls they were intended to be.
Literacy has been shown to be more easily and accurately acquired in deaf students who are schooled using signed oral languages, but due to the difficulty of translating certain grammatical markers from a spoken language into a signed one, oral grammar cannot always be accurately transcribed into the grammar of the transliterated one, leaving deaf students with gaps in their grammatical knowledge which still leave them at a significant disadvantage when learning to read and in other areas of academia (Rendel et al., 2018).

4. Shared reading

One tool that is studied in the acquisition of literacy among all populations of readers is shared reading. Shared reading is the act of parents or guardians reading texts with their preliterate children. This occurs with no specific phonological training- i.e., parents do not stop to connect the three letters in the word ‘cat’ with the phonemes /c/, /a/, and /t/. Because of this, any direct literacy skills that develop as a result of shared reading will likely rely entirely upon the lexical route (Berke, 2013). Development of word recognition skills is not the only benefit of shared reading- shared reading also gives children a strong foundation for the development of the soft skills that aid literacy, such as recognition of story structure and empathy (Berke, 2013).

It may seem a difficult task to engage in shared reading with deaf children; after all, both the written word and sign language are visual, and the eyes can only focus on one thing at a time. However, deaf parents, like most parents, do engage in shared reading with their children and have developed specific techniques to make the transition from sign language to the written word simpler for their children: “For example, mothers will sign on the book to be within the child’s visual field; maintain attention by physically touching, tapping, or moving the book (Lartz & Lestina, 1995; Swanwick & Watson, 2005); and use nonmanual behaviors such as facial expressions or shifts in eye gaze to demonstrate character changes.” (Berke, 2013, p. 300)
Shared reading in deaf communities has been studied in the past, although not as extensively as shared reading in hearing populations. One such study, performed by Berke (2013), provides a helpful overview of the differences and difficulties encountered by signing parents in shared reading with their signing children. Berke’s study was primarily observational, seeking to identify and discuss techniques deaf mothers used when reading to their pre-literate children. Ten deaf parents were observed reading with their children; all had either undergraduate or post-graduate degrees, and half were teachers. Additionally, all came from white, middle-class families. This sample may seem heavily biased in one demographic direction – however, the number of deaf children born to deaf parents is already small, and it is possible that these 10 participants were the only ones able to fit the study’s criteria.

Berke’s study shows that shared reading helps to instill several important links between sign language and both the written word and the spoken language on which it is based. For instance, shared reading provided unique opportunities for parents to teach their deaf children foundational skills which later will be important in the further development of their literacy: for instance, all parents, regardless of their level of professional education, explained the concept of rhyming to their children, pointing out that certain words which are spelled similarly will also sound the same, such as the words *behave* and *cave*. Additionally, deaf parents took care to explain the meanings of words which may have the same definition in both ASL and English but entail different things in both languages: for instance, the word *listen* in English is linked to hearing, whereas in ASL, the same word is linked to vision.

Another issue that arises in the learning of literacy for those with a sign language as their L1 is the differing grammatical structure of the orthography and the sign language. For instance, ASL contains neither definite nor indefinite articles, nor does it contain ‘to be’ as a linking verb
(Berke, 2013). Additionally, sign languages and the oral languages whose orthographies deaf children are taught often have differing syntax. For instance, English is a subject-verb-object (SVO) language: the only way to express the idea of a dog biting a man in English is to say the dog bites the man. ASL, however, can either use an SVO structure or an OSV (object-subject-verb) structure. In ASL, signing the man the dog bites has the same meaning as the previous ordering. This has the potential to create issues in the correct linkage of sign to written word. The deaf mothers in Berke’s study mediated this issue by only signing in English word order when translating the book into ASL and were also observed fingerspelling function words such as the verb to be which did not exist in ASL.

Ultimately, the foundation on which all of these techniques rest returns to the LIH and the early language access hypothesis. Without early sign skills, deaf children will not benefit from shared reading, as they have no basic language to engage in the back-and-forth communication that shared reading depends on. However, the way in which shared reading instills literacy skills in young children has been shown to be non-phonological in nature. Children who learn to recognize words in this way are not performing any phonological decoding, as indicated by the results of the Berke (2013) study, but are rather utilizing the lexical route of reading described by the DRT. It is possible that the lexical route is the primary – or perhaps only – route which is utilized by deaf readers even after they have been exposed to phonological data. This theory will be expanded upon in Section 5 below.

5. Specific mechanisms in literacy

We know why signing skill and reading skill are related in deaf students. How deaf students translate these superior language skills into reading skills is another question. To understand the challenges and perspectives that go into teaching those without sound how to read a phonemic language, we must first understand current thought on literacy acquisition in the field
of psycholinguistics. The importance of basic language skills in strong future reading skills has previously been emphasized; however, we will now discuss which linguistic processes are thought to be central to literacy acquisition both in hearing children and deaf children.

There are several different cognitive models of reading; however, the most well-supported, as stated in the introduction, is the DRT. As stated in the introduction, the DRT posits that there are two separate cognitive routes - phonological and lexical - used in the acquisition of reading; if one is impaired, reading may become more difficult, but will not necessarily be impossible. The lexical route is most commonly used in education to teach kids to recognize common words such as pronouns or articles such as the. The more commonly known route - and the one which deaf readers find more daunting a task to use - is known as the non-lexical route, but will be referred to as the phonological route within this thesis for better differentiation between the two. The major benefit of the phonological route is that it allows readers to sound out unfamiliar words by reading each individual letter that makes up the word; it also enables them to read words out loud which do not yet exist in their vocabulary. Lexical reading is often of more importance in languages which have deep orthographies like English - i.e., orthographies which do not have a strong connection between each individual letter and specific sounds (Kargin et al., 2012).

5.1 Phonological knowledge.

Almost all literature on reading deficits focuses on the phonological route and on a specific cognitive skill called phonological decoding. Decoding is the ability to take individuals letters and words and break them into pieces to process separately. In the discussion of reading, phonological decoding is often seen as most important (Snowling & Hulme, 2011). It has been shown that intense training in alphabetical skills in children who suffer from dyslexia has been proven to be very effective in its treatment (Snowling & Hulme, 2011). However, children with
dyslexia often suffer primarily from difficulties in phonological decoding. Other types of reading difficulties such as comprehension difficulties are better predicted by a child’s ‘higher level’ language abilities, such as semantics and grammar (Snowling & Hulme, 2011).

In order to fit deaf readers into this framework, we must first understand what specific language difficulties those in deaf populations have and how the issue of phonology comes into play- and whether or not phonological skills in deaf literacy are as important as they are in hearing literacy at all. Using the DRT, it may be that, although deaf readers struggle more with phonetic processing of words, they rely more heavily on word recognition skills, utilizing the lexical route more so than the phonological route.

When reading, the phonological skills that help hearing children to sound out unfamiliar words serve little use to deaf children. Furlonger et al. (2014) states, “Indeed, in a recent meta-analysis, phonological knowledge only predicted 11% of the variance in deaf children’s reading proficiency (Mayberry, del Giudice, & Lieberman, 2010).” (p. 2) However, there is evidence that deaf children are aware of which words rhyme in spoken language (Waters & Doehring, 1990). It is possible that successes on rhyme identification tasks in deaf readers can be explained simply by the ability to identify similar or identical strings of letters in different words, such as the -ing in the rhymes wing, thing, and ring; whether or not such knowledge can be considered phonological rather than a matter of simple pattern recognition is debatable.

A study by Waters and Doehring (1990) sought to answer a similar question by giving deaf participants words which contain the same strings of letters but which do not necessarily contain the same pronunciation in English, such as the words couch and touch, which, despite differing only in the first letter in their spelling, do not share the same ending pronunciation in English (Furlonger et al., 2014). Here, errors were considered to have occurred when participants
either marked word pairs that rhymed as not rhyming, or vice versa. Simply put, the results of
this study showed that deaf children made more of these errors on the word pairs of the same
type as *couch-touch*, marking them as rhyming when, phonologically, they do not. The results of
this study, according to Furlonger et al. (2014), suggest that, “deaf children were not accessing
the sounds of words in word recognition,” (p. 2) but rather the visual component of written
language which indicates a rhyme.

Surprisingly- or perhaps not surprisingly, given what we know about the effectivity of
exclusive oral training for deaf children- even deaf readers with limited or no signing ability who
had been ‘taught speech’ through lipreading and oral cues did not demonstrate that they relied on
phonological knowledge in rhyme-based tasks either. Furlong et al. (2014) uses an example from
Campbell and Wright (1998), who “argued that because the orally educated deaf could not match
accurately for rhyme when the words did not share the same spelling, this was evidence that they
were not able to achieve a reliable phonological representation of speech from lip-reading and
residual hearing alone…” (p. 4) Given that oral education aims to instill phonological skills in
deaf learners, its failure here is particularly indicative of its overall poor effectiveness.

We know that phonological skills are unimportant in even (or perhaps especially) the best
deaf readers, and thus, we can move away from the phonological route described by the DRT, as
the above points, as well as Section 2’s evidence that profoundly deaf children have severe and
often insurmountable difficulties with auditory phonology, show that profoundly deaf
populations will be better served if a different method of literacy acquisition is used. Using the
DRT, there is only one option left: the lexical route.

5.2. Vocabulary knowledge.

If it is the lexical route which is best utilized in the best deaf readers, then there are
certain linguistic skills which may contribute to better use of this rout. One of these skills is
vocabulary robusticity. It has been hypothesized that one of the reasons why superior signing skills relate to superior reading skills in deaf populations is because those who sign, among other things, have a stronger and more robust vocabulary than those who struggle through oral training. Trying to teach a child a novel word when they are just beginning to learn to read in an auditory language unfamiliar to them can be a challenge; however, there is much evidence that shows that deaf readers do not read the English language (or any other applicable oral language) in English. Rather, they conceptualize a written word in their head as the equivalent signed word: “they will understand the meaning of written words within the preexisting sign language system. Thus, deaf children initially remember written words by creating associations between written words and their translation equivalents in sign language.” (Hermans et al., 2008, p. 519) This form of whole-word-to-sign coding is essentially the definition of the lexical route the DRT describes- written words are not processed letter-by-letter, but as a whole symbol.

The discussion of vocabulary robusticity in deaf students is important in another area of literacy studies- deaf readers often have the most difficulty reading texts which use academic language. Academic language, such as the language style used in this thesis, is separate from colloquial language in that it is “authoritative and detached”, whereas colloquial language is “expressive and interactive” (Scott, Hoffmeister, 2017, p. 60). One particular issue with the proper acquisition of academic languages is best explained by a quote from Scott and Hoffmesiter (2017) regarding the academic language of English: “Academic English also typically features wider range of lexical diversity than colloquial language to facilitate clear communication with those reading one’s academic writing.” (p. 60) This essentially means that academic languages often require a broader vocabulary to properly obtain the intended meaning from the text.
Scott and Hoffmeister (2017) posit that deaf readers have more difficulty with academic English because they are expected to learn it when they have not yet mastered what they refer to as basic interpersonal communication skills (BICS), nor do these students have a native language base for mapping this new, unfamiliar structure of language onto: “... language minority students are at a disadvantage for acquiring academic English because they may not be exposed to or participate regularly in academic discourses in their native language.” (p. 60) In their 2017 study examining the academic language proficiency of deaf readers, they discovered a number of important things, the first being that, again, reading ability across all scales is improved by signing ability. However, their most important contribution is this: “In more transparent orthographies, it is likely that once decoding is mastered, language proficiency becomes the key predictor of reading comprehension. In contrast, in an opaque orthography, higher levels of decoding are more intertwined with language proficiency, as decoding orthographically opaque words will be facilitated by language proficiency.” (p. 67)

Languages which have more opaque orthographies rely more heavily on the lexical or word-recognition pathway when reading. This means that a person’s ability to link a written word or symbol to a word requires pre-existing knowledge of that word in their own native language, thus, a more robust vocabulary can better predict a person’s ability to read using the lexical pathway. For deaf readers, any orthography which is based on the phonological system of an auditory language which deaf students have no access to can be considered fully opaque. Therefore, the lexical pathway more so than the phonological pathway becomes fundamental in the development of strong reading skills in these populations.

Whether deaf children are utilizing either the phonological or lexical routes of the DRT is important to note because it is likely that deaf signers will be educated differently than deaf non-
signers. Deaf signers may not be expected to learn to read in the same way that deaf non-signers will be; in the absence of a pre-existing sign language onto which educators and parents can map the written word, techniques used by teachers of hearing children will be the only remaining option. We know from Section 2 that the orally-educated profoundly deaf rarely grasp full language and will be left with a limited grasp on language as a whole, especially the sounds of that language – therefore, attempting to teach these children to read using either word recognition skills or phonological decoding skills will likely fail.

6. The effects of orthography on literacy

There is some evidence that shows that a language’s orthographic depth – or how dependably a single letter can be expected to produce a single sound – can affect the relative ease with which deaf students acquire literacy in that language (Clark et al. 2016). English is a language considered to have what is known as a deep orthography- words like ‘enough’ and ‘daughter’ are not pronounced by reading the sound that corresponds with each individual letter, and there are an abundance of letter ordering rules that dictate how a word is supposed to be pronounced, such as an ‘e’ on the end of a word changing the sound of the first vowel that comes before it. German, on the other hand, has a shallower orthography- it has fewer of these order-based pronunciation rules and can essentially be spoken exactly as it is written. Shallow orthographies are generally considered to be more easily parsed, especially through the use of the phonological pathway of reading. It may be that readers of shallow orthographies are utilizing the phonological pathway more often than the lexical pathway.

Given what we know about how deaf readers utilize these different pathways, one would expect that deaf readers do not find one language more or less difficult to read in than another; a deaf child learning to read a shallow orthography such as German would be at no more of an advantage than a child learning to read in English. The question of orthographic depth and its
effect on deaf literacy is one that Kargin et al. explored in their 2012 study on how deaf students learn to read across countries and across languages, both oral and signed. Their paper specifically examined deaf readers of Arabic, German, Turkish, Hebrew, and English, and aimed to compare the shallow orthographies (Turkish and German) against the deeper orthographies (Arabic, Hebrew, and English) (Clark et al., 2016).


In their study, Kargin et al. (2012) tested two different conditions to test this hypothesis: perceptual judgment and conceptual processing. Perceptual judgment was tested by having participants judge whether or not two words, presented in the same font, were the same, whereas conceptual processing tested the same thing, but with word in a pair presented in two different fonts, one printed and one in cursive. In the first condition, only a visual analysis is necessary to determine whether the two words are the same or different, whereas in the second condition, the participant must identify words using pre-existing knowledge of grapheme-phoneme encoding or lexical processing (Clark et al., 2016). Kargin et al. (2012) ultimately found no strong link between the depth of a language’s orthography and the specific reading difficulties encountered by deaf students.

The most marked difference in the expected results of this study were found in Turkish participants, who underperformed compared to both deaf and hearing participants in almost every task. This was in spite of the fact that Turkish is a shallow orthography; however, it is important to note that, although all participants used sign language as their primary mode of communication, Turkish participants had been orally educated according to the official policies of the Turkish government, whereas all other participants came from educational programs which utilized some form of visual communication, whether it was a signed oral language or a natural sign language such as ASL (Kargin et al., 2012; Clark et al., 2016). Though the study did
not directly address nor fully explore the implications of this, both Kargin et al. (2012) and Clark et al. (2016) note that the results of the Turkish participants may have been related to their country’s model of education. However, it is interesting to note that German participants also exhibited lower performance on conceptual tasks compared to all other participants except the Turkish group. Perhaps German’s nature as a shallow orthography is responsible for this in a practical way rather than a theoretical one: it may be that teaching resources for learning German literacy are focused on phonological decoding skills rather than word recognition skills. More research into the effect of different teaching styles across countries and orthographies needs to be done to tease apart the effects of sign language and education method on deaf literacy.

Taken together, the results of both shallow orthography languages strongly indicate that, for deaf readers, the orthographic depth of the language in which they read has little bearing on their ability to read quickly and accurately. This supports what was hypothesized in the beginning of this section: deaf readers do not utilize phonological knowledge when reading, and thus will not benefit from shallow orthographies in the same way that hearing readers do.

6.2. Clark et al. (2016)

Several years after Kargin et al. (2012) performed this study, Clark et al. (2016) attempted to duplicate the results as well as explore new areas of interest with a second study. For instance, deaf participants were also split into two groups: deaf of hearing (DOH) participants who had acquired their signing later in life, and deaf of deaf (DOD) participants, who had acquired their signing early. Additionally, the study also included data from hearing dyslexic participants and compared the results of deaf and hearing participants against these dyslexic participants as well. As discussed in Section 3.1, dyslexia is considered to be a phenomenon rooted primarily in difficulty in phonological decoding and processing. Clark et al. (2016) states, “If deaf participants’ reading difficulties are related to the dual route reading
theory, then their [reaction times] would be hypothesized to be similar to [dyslexic participants’ reaction times].” (p. 132) However, this statement requires further specificity, as it does not distinguish between the two different pathways described by the dual route theory. We know that deaf readers do not utilize phonological knowledge when reading; therefore, assuming that deaf literacy may be completely unrelated to the DRT, only half of which has anything to do with phonology, is an unnecessarily broad assumption.

Clark et al. (2016) used the same basic task used in the original 2012 study – presenting two words in either the same font or one printed and one in cursive – and found, again, that the orthographic depth of a language does not correlate with stronger or weaker results in the task. However, significant differences were found in the reaction times (RTs) between participants “with full access to an early L1 (hearing and deaf of deaf participants)” (p. 143) and participants whose access to an L1 was inhibited (deaf of hearing participants). This indicates support for the LIH and early language access theories – once again, children with earlier access to an L1 and better foundational knowledge of language as a whole are shown to perform better on literacy tasks. Additionally, it was found that deaf participants had few significant similarities to performance on either the perceptual or the conceptual tasks by dyslexic participants, indicating that “reading difficulties for deaf participants are [not based on] word decoding skills or phonological problems.” (p. 144)

Because both studies investigating the ODT found that it has limited theoretical relevance in explaining reading ability in deaf populations, we can conclude, for the purposes of this thesis, that it does not answer the question as to why deaf signers are better readers. Additionally, the ODT has limited real-world application compared to other theories of reading- it is unrealistic to expect deaf students living in different parts of the world to learn an orthography which differs
from the orthography of the oral language of their region, especially due to written language’s ability to act as a translation aid between hearing and deaf communities, as well as its ability to eventually facilitate any oral language skills which may eventually be taught. Compared to the limited effectiveness of the ODT, the LIH and the DRT have a dearth of potential practical applications in deaf education, and therefore, these are the theories which should be researched in more depth. However, the ODT does provide more evidence for the fact that deaf readers do not utilize phonological knowledge while reading.

6.3. Soundless writing systems: deaf literacy in China

We know that orthographic depth does not necessarily have a strong effect on deaf literacy. However, this fact may be limited to orthographies which rely on the phonology of oral language. The majority of the world’s written languages utilize a phoneme to grapheme conversion system, meaning that each letter does not in and of itself contain a unit of meaning, but rather a simple unit of sound. However, if prelingually deaf children have no access to the auditory phonology off of which these phonetic orthographies are based, then it is worth asking the question of whether or not they might be more adept at learning an orthography which has little significant and reliable connection to auditory phonology.

The most utilized and studied orthography of this type is the Chinese character system, which consists of thousands of different characters which, in general, represent units of meaning rather than units of sound: Chiu et al. (2016) describes Chinese as, “…a language with low orthographical transparency. A Chinese character provides relatively little information regarding pronunciation, especially for a beginner or for an individual with limited sound input.” (p. 79) Unlike purely phonetic orthographies, Chinese characters consist of two parts: a semantic part which indicates the category of the word and a phonetic part which suggests the sound of the word. However, the phonetic part cannot always be relied upon to predict a word’s pronunciation.
(Chiu et al., 2016). Because characters have little to no connection to the sounds of the language, Chinese characters can often be used by two speakers of mutually unintelligible Chinese dialects to facilitate communication; it is possible that deaf signers living in China and utilizing this orthography are able to use it in a similar fashion, as well as process it similarly to hearing individuals. More broadly, it is possible that the best deaf readers in countries which do not use a non-phonetic orthography treat the written word the same way that deaf and hearing readers of Chinese characters do, by mapping their own base or first language onto the written word.

Chiu et al.’s experiment does not explicitly examine reading ability in deaf populations: rather, it examines whether or not deaf participants were able to glean phonological knowledge from Chinese characters, which provides valuable new insights into deaf literacy and phonological processing, as the majority of studies which examine phonological knowledge in deaf populations have been done in English-speaking countries and on users of ASL (Chiu et al., 2016). If the study finds that phonology is important when deaf participants process Chinese characters, it would not necessarily be evidence for the phonological route in the DRT because, although phonological knowledge is used, the decoding skill is not, which is what the phonological route is primarily based upon.

Chiu et al. (2016) examines the question of how fluent signers of Taiwanese Sign Language (TSL) parse and process words written using Chinese characters. The study uses homophone identification tasks – tasks where readers are asked whether two given words have the same spoken pronunciation despite having different meanings – and lexical decision tasks to test its hypothesis. The expectation for this study was that signers would more reliably confuse written words which are homophones in TSL rather than those which sound the same in spoken Chinese; this expectation is similar to the results of another study discussed by Goldin-Meadow.
and Mayberry (2001) which found that deaf signers confused written words that were similar in sign but not in orthographical representation or oral language.

The study was broken into two different experiments: both were done with 24 deaf participants, all adults, all native users of TSL, two of whom had deaf parents. The sample was described as having highly variable reading ability, so only characters with a high reported frequency in everyday usage were utilized. Accuracy was the only measure analyzed in deaf participants, as the task was expected to be more difficult for them; speed data would not have yielded theoretically significant data. This experiment utilized character pairs of four types: characters which were both pronounced the same and written with the same phonetic part, characters which were pronounced differently and written differently, characters which sounded the same but written differently, and characters which sounded different but were written similarly.

The first experiment was a homophone identification task, which aimed to determine the level of phonological knowledge deaf participants had when reading Chinese. Similar to other studies which have examined the role of phonology in deaf literacy, deaf participants were more accurate than hearing participants in two conditions: when two words were homophones and were orthographically similar, and when two words were not homophones and were orthographically dissimilar. Given what was discussed in Section 5.1, these results were to be expected and for the purposes of this thesis merit no further discussion.

The second experiment, however, aimed to determine whether native users of TSL accessed action-based phonology (i.e., the phonology of TSL rather than an auditory phonology) when reading Chinese characters. In this experiment, characters were divided into three groups: semantically related words, sound-based phonologically related words, and words unrelated on
both fronts. This experiment utilized a lexical decision task rather than a homophone identification task, meaning that participants were presented with Chinese characters, some of which had no real meaning, and were asked to identify whether or not the characters meant something. Here, participant RTs were recorded as a longer RT would indicate longer deliberation over whether or not the presented characters were words, which indicates that the presence of a priming effect. These priming effects were expected to either be phonologically-related or semantically-related. Similar to the results of the previous experiment, deaf participants showed no indication that they were accessing a sound-based phonology while completing the task; hearing participants showed both semantic priming effects and phonological priming effects, while deaf participants only showed the first. Despite the researchers’ earlier reservations about the variability of literacy within the group, both hearing and deaf participants demonstrated the same levels of accuracy in the task, only differing on priming effects.

6.4. Linking the ODT to phonological skills

Given what we know about deaf students and usage of the phonological route, the previous findings from Kargin et al. (2012), Clark et al. (2016), and Chiu et al. (2016) make sense: orthographic transparency has no bearing on how easy reading is for deaf students as all orthographies for deaf readers are fully opaque, just like Chinese characters. It appears that the ODT not useful in its original context, which was simply to judge the effect of orthographic depth on deaf literacy, situations which rely upon those being studied within its framework having a working knowledge of phonology, which the profoundly deaf rarely do. The ODT may be more useful in analyzing reading ability through the phonological route, perhaps in dyslexic readers, rather than the lexical route, which deaf readers tend to more heavily utilize.
7. Conclusion

We have seen evidence from each of the three key theories mentioned in the introduction: the LIH, the DRT, and the ODT. We know that phonological skills, inaccessible to prelingually and profoundly deaf students, do not predict or aid reading ability in deaf populations, and that a language’s orthographic depth does not have any effect on deaf literacy as a result. We know that, because of their limited access to phonology, deaf children learn to read best through the use of the lexical route rather than the phonological route. However, ultimately, the answer as to why deaf signers are better readers boils down to this: no one can be expected to learn how to draw if they do not first learn how to hold a pencil.

The DRT tells us how deaf signers read – it does not tell us why deaf signers are better readers than the orally-educated deaf. Ultimately, the functionality of the DRT is dependent on the robustness of the individual’s vocabulary and other pre-existing linguistic skills which can be best acquired through full and regular access to a learnable first language, which, given the sources outlined in Section 2, for profoundly deaf children, is signed rather than spoken language. The profoundly deaf cannot be expected to develop the language mastery necessary to learn and full utilize what can be considered a second language when the first has not been fully acquired: in order to build a house, you must first have a strong foundation. Deaf signers have a better framework into which they are able to map the written word; deaf children who are orally trained lack this framework, and as such, have poorer reading outcomes. Though the DRT offers an explanation of some of the things seen in deaf signers’ reading, everything eventually comes back to the LIH and the idea that early access to a language is essential for the development of strong literacy skills. These findings have important implications for deaf education and advocacy which should be taken into account in the future.
8. References


