Parental Hearing Status and Sign Language Use as Predictors of English Literacy Outcomes for Deaf Children in a Bilingual Educational Setting

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Parental Hearing Status and Sign Language Use as Predictors of English Literacy Outcomes for Deaf Children in a Bilingual Educational Setting

by

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Experimental Psychology

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Abstract

Deaf children in the United States are not achieving age-appropriate literacy in English. Nearly 90-95% of deaf infants are born to hearing parents who do not know American Sign Language (ASL). These deaf children are experiencing limited access to a spoken language and as a result do not develop skills needed to be prepared for academic learning because language acquisition during the sensitive period in development is crucial for the development of literacy skills. However, 5-10% of deaf children have deaf parents who use ASL. Studies show correlations between higher ASL fluency and higher English literacy scores in deaf children from deaf parents. The current study uses NWEA Measures of Academic Performance (MAP) Literacy data from 778 deaf children attending ASL-English bilingual school in the Southwestern United States to examine pathways by which ASL can boost print English literacy using Vygotsky’s social cultural theory of language and cultural development. Covariates included socio-economic status, age of ASL exposure, and age of entry to school. It was predicted that (1) deaf children from signing parents would show faster growth in their MAP literacy and (2) within families who report signing, those from deaf parents will show faster literacy growth than those from hearing parents. Results from a multi-level modeling analysis showed that deaf children from signing parents had a 2.5-year advantage on their MAP performance at school entry and deaf children from deaf signing families had a 4.5-year advantage on their MAP performance at school entry. Implications for effects of covariates on the growth models are discussed. 

Keywords: early exposure, sign language, deaf children, literacy, bilingual-bicultural deaf school, signing parents, deaf parents.
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Parental Hearing Status and Sign Language Use as Predictors of English Literacy Outcomes for Deaf Children in a Bilingual Educational Setting

Many deaf children struggle to achieve age-appropriate literacy in written English (Marschark & Harris, 1996). It has been argued that the acquisition of natural language during a sensitive window in development is crucial for the development of reading and writing skills, and that this early language exposure can be to either a spoken or signed language (Goldin-Meadow & Mayberry, 2001). Indeed, many studies on the development of print literacy skills in deaf children supports the correlation between American Sign Language (ASL) proficiency and literacy outcomes (Hoffmeister, de Villiers, Engen, & Topol, 1997). Research has also shown that deaf children of deaf parents acquire ASL as an L1 with typical developmental milestones and tend to be more successful readers and writers than deaf children of hearing families (Lederberg, 2006). For deaf children in hearing families, the home language is usually spoken language and is not fully accessible to the deaf child. Additionally, in many situations, the home spoken language may not correspond to the language of instruction in the schools.

In the current study, we use archival longitudinal data from a deaf bilingual-bicultural residential school in the southwestern United States to determine the trajectories for written English literacy for deaf students with deaf and hearing parents who use a signed and/or spoken language as their dominant home language. Furthermore, we include important covariates such as social factors (SES), educational factors (year of entry to residential school) linguistic factors (age of exposure to ASL) and audiological factors (age of hearing aid fitting, unaided pure tone average hearing loss, age of access to audiological services) in order to better account for

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1 L1 is an abbreviation for first language.
variability in literacy growth trajectories. The goal of this longitudinal study is to provide insight into malleable and non-malleable factors responsible for literacy outcome disparities in deaf children.

The early development of literacy skills in children is influenced by a wide range of factors such as cognitive processes, amount of language input, the number of books in the home, the amount of time child spends reading, and the amount of time parents spend reading to their child. The child needs to be both exposed to print, and to have the linguistic and cognitive resources necessary to understand it.

We know that cognitive processes develop rapidly during the first few years of life and that the greatest amount of cognitive growth occurs between birth and five years of age (Eliot, 1999). A child begins to develop language skills long before they are able to speak and read (National Research Council, 1998). Given what we know about the process of cognitive development, it is not surprising that young children exposed to early language and literacy experiences are primed to become good readers later in life. Emerging literacy skills developed prior to school entry are among the most important predictors of how well children will read once exposed to formal literacy education (Lonigan, Burgess, & Anthony, 2000). Such experiences include conversations, stories, and book reading (Parlakian, 2003).

Parents also play an important role in contributing to their child’s literacy development. When parents read aloud to their child, they are not only stimulating the child’s language and cognitive skills, but also building their motivation, curiosity, and memory. The children whose parents read to them are likely to become better readers and perform better in school (Moss & Fawcett 1995; Saracho 1997; Snow, Burns, & Griffin, 1998). Activities such as reading aloud allow a positive interaction to develop between child and parent; high quality parent-child
interactions are essential for the development of literacy (American Academy of Pediatrics, 2014). The amount of time parents spend talking to their child is also of great importance. Parents who talk as they go about their daily activities expose their child to approximately 1,000-2,000 words per hour and, in the process, children are subconsciously learning rules of grammar as well as the social context of communication (Hart & Risley, 1999). For deaf children, therefore, parents play an important role in promoting their child’s literacy development through “signing storybooks aloud” to them.

**Social-Cultural Theory of Development**

As individuals develop, there are various opportunities and restrictions for learning. Learning is enhanced when differential development within and across physical, intellectual, emotional, and social aspects is taken into consideration (Learner-Centered Principles, 1997). Lev Vygotsky’s *Sociocultural Theory of Development* states that children learn from their interactions with society and their culture, and with additional help, they can continue to acquire knowledge (Vygotsky, 1978). Related to this is the idea of Zones of Proximal Development (ZPD), which is the theoretical basis for “scaffolding”. Some individuals may have skills they can perform independently, while other skills can be performed only with assistance. Skills that can be performed only with assistance are said to be within an individual’s ZPD (See Figure 1) and scaffolding is intended to help learners through the ZPD, and then to be removed later. In other words, ZPDs are the moments when skills that the individual has not yet developed are being scaffolded and acquired.

The major theme of Vygotsky’s theoretical framework is that social interaction plays a fundamental role in the development of cognition. He believed that humans engagement and interaction is innately social and cultural, and that learning does not take place without it. We can
draw from sociocultural theory to frame literacy as a social practice that is shaped by social and cultural factors (Vygotsky, 1978). This sociocultural perspective highlights the role that culture plays in the development and practice of literacy. It emphasizes development of literacy as dependent on interactions between individuals and the tools that culture provides to those individuals in order to support their learning. As a result of this interaction and the available cultural tools, the development of values, ideas, attitudes, and knowledge occur (Miller, 2002; see Figure 2 for a visual description of this developmental process). One kind of tool that Vygotsky believed was helpful for navigating day-to-day activities and increasing a child’s ability to solve problems was psychological, e.g. language, mnemonics, and gestures. For Vygotsky, therefore, language is an internal mediator between an individual’s cognition and their social world (Vygotsky, 1986). He believed that this mediation was crucial and considered it to be “formal education” (Kozulin, Gindis, Ageyev, & Miller, 2003). For example, children can learn early on about the adult roles of their society through role-playing. Specifically, when a parent talks to their child about information related to the world, they are framing how culture interprets the world and in turn, this promotes cognitive development. While schools are a formal way to pass knowledge on to children that adults in our society deem important, there is a significant amount of informal education that occurs during parent-child interactions.

Culture-specific social interactions in children’s everyday activities play an important role in language and cognitive development (Bruner, 1983; Vygotsky, 1978). Typically, once infants are born, they are exposed to environments of people speaking and a language that their primary family members use. This experience of being exposed to spoken language in their environment is not the same for deaf infants who are born to hearing parents. In fact, more than 90% of deaf babies are born into this type of environment where spoken language, rather than a
visual language like a sign language, is used (Mitchell & Karchmer, 2004). Additionally, these parents often don’t realize their child is deaf until the age of 2-3 years. Due to their deafness, deaf children do not hear sounds and do not naturally comprehend the spoken language that surrounds them (NIDCD, 2014). Hearing parents of deaf children often are unaware of or do not receive resources on how to communicate with their deaf child. As mentioned earlier, this can impact language acquisition and social-cognitive development. There is a phenomenon called the ‘Dinner Table Syndrome’ that is used within the deaf community to describe their shared experiences in home environments where parents did not communicate using ASL (Hall, Smith, Sutter, DeWindt, & Dye, 2018). Dinner Table Syndrome describes the interactions that take place within a family during dinner, or similar family gatherings. Families will often discuss real-world events, what took place during their day, or even have heart-to-heart conversations. Imagine a deaf individual at dinner and their family is conversing: the child cannot hear their interaction and family members may alternate back-and-forth between talker and listener, and may even talk over each other. All of this results in missed access to vital social behaviors that need to be learned, and results in the deaf individual feeling lost and isolated. Most of the deaf child’s time is spent trying to decode what is being discussed and they perhaps may not participate in the conversation at all. They may ask a family member what is being said and be told “I’ll tell you later” or “It’s not important”.

Deaf individuals also experience Dinner Table Syndrome within wider society, where they interact with individuals who are not able to communicate with them through a visual sign language. Deaf individuals do not have access to incidental learning experiences in situations where hearing individuals share information with each other in a way that is not accessible. Incidental learning refers to any learning that is unplanned or unintended in an informal or
formal learning environment. This type of learning occurs in everyday communication including emotional expression, navigating arguments, and managing triggers. Hearing individuals are not intentionally excluding deaf people. Rather, they are accustomed to understanding everything that is going on and being said and therefore they do not comprehend the impact it can have on a deaf individual. Dinner Table Syndrome is important to consider in a deaf child’s literacy development especially when we draw from Vygotsky’s belief in the importance of informal education that occurs at home during parent-child interactions.

Culture

Deaf culture includes a set of learned behaviors employed by people who are deaf and who have their own sign language, values, rules, and traditions (Gallaudet Clerc Center, 2020). One important value that is relevant to the development of literacy is promoting a visual-spatial environment that is “vision-friendly” for communication in their home, at their school, and within society. Vision offers deaf individuals’ direct access to information about the world and allows them to contribute across every aspect of their community. Members of the Deaf community express strong support for bilingual ASL/English education of deaf children (described later). Preservation of Deaf culture is also valued and is expressed through a variety of traditions, including but not limited to films, literature, and poetry. Even more so, deaf children are valued as the future of the Deaf people.

Deaf parents offer a unique perspective on communication with a deaf child. For instance, deaf parents commonly use nonverbal communication as one of their communicative techniques. Such nonverbal communication can include facial expressions, body movement, gestures, eye contact, touch, and use of space (Blatner, 1985). Facial expression is not only an important nonverbal cue, but it is an essential part of all visual sign languages. Facial expressions
such as happiness, sadness, anger, surprise, fear and disgust are used to support and communicate in a sign language like ASL. This is different compared to how hearing individuals relay these emotions, which they usually do through changing the tone of their voice. Eye contact is important for maintaining flow of conversations and for visually perceiving ASL and for the inclusion of conversations (Agrafiotis, Canagarajah, Bull, & Dye, 2003; Emmorey, Thompson, & Colvin, 2009). Along with this is the space between individuals that allows seeing body movements, facial expression, and ASL. Touch is valued within the deaf culture especially for getting one’s attention (tap on the shoulder) rather than attempting to yell/call out for attention getting. Studies have shown support for nonverbal cues affecting students’ learning and these nonverbal cues are often use by deaf parents (Smith & Ramsey, 2004). These skills all can contribute to deaf children arriving at school prepared and knowing how to look for visual information/cues in their surroundings. Hence, it is not that deaf children are unable learn, but rather that their ability to learn is impacted because the adults they were raised and taught by were not prepared to (or unaware of how to) communicate with their deaf child effectively. Consequently, deaf children with parents who are not skilled visual communicators often do not learn at a similar rate to those with hearing children (Bienvenu, 2008).

Supporting this idea, Vygotsky’s sociocultural theory of development provides a framework for examining a deaf children’s early environment (Vygotsky, 1978). Vygotsky’s insights into the links between the processes of social interaction and cognitive development emerged from his studies of deaf children in Russia. He argued that the presence of sign language is necessary in all aspects of the deaf child’s environment and that spoken language was inadequate for allowing deaf children to acquire cultural experience and subsequently to participate fully in society (Vygotsky, 1978). The interaction between cognitive development
and social interaction, Vygotsky argued, involves using languages shared by children and parents to develop cultural tools to make sense of the world.

Cognitive development is central to sociocultural theory and one aspect of cognitive function of particular interest when considering deaf children is executive functioning (EF). EF is supported by language development, which occurs through social interaction. EF is the higher-order cognitive processing that controls metacognition and behavioral regulation (Roebers, 2017). The development of EF begins before birth and continues into early adulthood (Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001). Research has shown that EF in deaf individuals is influenced by environmental factors, such as language use at home and in the school, and can be negatively impacted if a deaf individual experiences language delay (Hauser, Lukomski, & Hillman, 2008). Studies of deaf children from hearing non-signing families (DCHP) reveal evidence that these children are at risk for delayed EF development (Pisoni, Conway, Kronenberger, Henning, & Anaya, 2010) while deaf children who acquire a natural sign language from Deaf parents (DCDP) develop typical EF skills (Marshall, Jones, Denmark, Mason, Atkinson, Botting, & Morgan, 2015). The typical language and cognitive development of these DCDP could be a result of having shared language, social interaction, and/or the parents’ understanding of how to communicate with a deaf child (Morgan & Dye, 2020). It remains a challenge for DCHP to experience early access to proficient sign language interaction. In some cases where DCHP acquire sign language at home it may be with only the primary caregiver, thus leaving them still excluded from full access to overheard conversations and ambient language (Hall, Smith, Sutter, DeWindt & Dye, 2018).

Many deaf children without early access to a natural signed language start school unprepared for academic learning (Erting, 2003). Erting argued that a severe lack of language
exposure, an absence of beneficial home literacy practices, and a lack of understanding about deaf identity and the cultural values of ASL are major barriers to obtaining print literacy skills. It is especially challenging when deaf children do not get opportunities prior to preschool to experience a fully developed language system: the early literacy development of deaf children from signing families (DCSF), when compared to deaf children from non-signing families (DCNSF), is more similar to that of hearing children (Akamatsu & Andrews, 1993; Andrews & Taylor, 1987; Maxwell, 1984).

What is it about access to a visual (sign) language that prepares a deaf child for acquiring literacy in a written language? Observing how deaf parents interactively read with their deaf children and set up a visual literacy environment provides researchers with a framework for what the development of visual language looks like (Akamatsu & Andrews, 1993). Parents who are deaf and sign give deaf children the sociocultural experience of full access to a visual language by adults who understand how to support visual attention skills and visual language during the sensitive period of language acquisition (Corina & Singleton, 2009).

A longitudinal case study performed by Maxwell (1984) was one of the first studies to note how deaf parents influence a deaf child’s print literacy development. Maxwell observed a third-generation deaf child\(^2\), Alice, from the age of 21 months to 6 years. Videotapes of social interactions between Alice and her deaf mother were observed. It was noted that, over time, interaction with books allowed Alice to gradually improve her picture-labeling and emotion-labeling skills based on the story. Despite other research suggesting deaf students are behind in

\(^2\) Third-generation deaf means that the child’s parents and grandparents were culturally Deaf and users of American Sign Language.
academic achievement compared to hearing peers, Alice’s reading achievement scores for grades 1-3 showed her to be performing at grade level. Within a sociocultural theoretical framework, Alice’s parents supported her language development by making stories visually accessible using ASL. The deaf mother also used book-reading to make connections to Alice’s own experiences as a deaf individual. Lartz and Lestina (1995) examined different strategies that deaf mothers use when reading to their 3-to-5-year-old deaf or hard-of-hearing children. Researchers examined videotapes of six deaf mothers who read the same book to their child. Two observers then transcribed and coded the videos revealing different types of strategies deaf mothers used when reading: sign placement, pairing text with sign demonstration, making real-world connection between the text and the child’s experience, attention maintenance, physical demonstration of character changes, and non-manual signals as questions. How deaf parents support home literacy practices will be returned to later in the context of how deaf children develop print literacy skills.

Language

If a first language is not acquired during a sensitive (or critical) period early in development, there are long-term impacts on both receptive language processing and productive language fluency (Mayberry & Eichen, 1991; Newport 1990). The sensitive period of language acquisition is from approximately birth to three years old and often deaf children are not exposed to language during this period (Humphries, Kushalnagar, Mathur, Napoli, Padden, Rathmann, & Smith, 2012). A sensitive period for language learning refers to a limited time window during brain development during which the learner is predisposed toward acquiring language. It is considered the maturational time period during which experiences will have their maximal effect on development. A child’s brain is naturally ready to learn language when they are born, and their brains are highly responsive to any natural language in their environment (Mahshie, 1995).
If language acquisition does not begin until after this sensitive period has passed, then it is believed that the capacity to learn language is decreased.

For a deaf child, then, there are significant risks for severe language delay and social isolation if they are not exposed to an accessible natural language, putting at risk their academic success later in life (Humphries et al., 2012). This is vital because language acquisition during this sensitive period is crucial for the development of literacy skills. Around 90-95% of deaf infants are born to hearing parents who do not know American Sign Language (ASL; Marschark, 2007). These deaf children are experiencing limited access to a spoken language, often with no ASL input, and as a result do not develop skills needed to be prepared for academic learning (Marschark & Harris, 1996). However, 5-10% of deaf children have deaf parents who use ASL (Mitchell & Karchmer, 2004) and these children typically show higher fluency in ASL than those from hearing parents (see later discussion).

**Social Interaction in Home**

The quality of social interaction, especially the interaction that takes place during literacy practices in homes with deaf children, can vary depending upon parents’ communication choices. The quality of a parent-child relationship is strongly related to a child’s communicative competency, and high-quality parent-child communication has positive developmental effects for deaf children (Quittner, Barker, Cruz, Snell, Grimley, & Botteri, 2010). A common barrier to quality of interaction during literacy practices for deaf children is the parents’ view of their child’s deafness. Roots (1999) describes three different reactions when hearing parents initially find out their child is deaf: (1) shock at the diagnosis of deafness itself, (2) realization that their own experiences of socialization will not be the same for their child, and (3) concern for the absence of a shared spoken language system. These negative reactions by hearing parents can
influence a deaf child’s self-esteem development (Marschark & Hauser, 2012). Additionally, hearing parents tend to play less with their deaf child, potentially leading to a lack of emotional bonding (Roots, 1999). However, these parents may not realize that playing with and reading to their deaf child are types of social interactions that can promote language learning and literacy (Curtain & Dahlberg, 2015). This is important to consider because literacy practices in the home are a major contribution to language and literacy development (Roots, 1999). A positive literacy environment includes both (a) interactive reading between parent and child, and (b) the resources to provide such an enriched literacy environment. Lewis, Sandilos, Scheffner-Hammer, Sawyer, and Mendez (2016) studied the expressive vocabulary and oral comprehension abilities (in both Spanish and English) of Spanish-English bilingual preschoolers in a Head Start program. Their data revealed that mother-child interaction, as well as the frequency of interactive reading at home between the mother and child, influenced a child’s Spanish language abilities, regardless of whether these interactions were in English or Spanish. Furthermore, literacy practices, such as the children telling the story themselves, were related to performance on English language measures, again independent of the language that the child used when reading. This supports the notion that it does not matter which language is used in the home; the important factor for children learning two language(s) is to have a positive home literacy environment. Additional research studies have also shown home literacy practices contribute to early language and literacy development (Beals & Temple, 1993; Korat, Arafat, Aram, & Klein, 2013; Snow, Dickinson, & Tabors, 1989).

Studies of mother-child communication involving deaf children with hearing mothers have documented how poor maternal communication skills have negative effects on a child’s language learning (Beckwith, 1977). Meanwhile, compared to hearing mothers, deaf mother-
child interactions demonstrate positive effects on both language and social-emotional development (Meadow, Greenberg, Erting, & Carmichael, 1981). In a longitudinal study, Schlesinger and Meadow (1972) examined the effect that deaf children’s language had on social interactions with their mothers. They studied four deaf children, two of whom had deaf parents, who all acquired a sign language as their first language. Three significant findings were observed: (1) acquiring a sign language did not interfere with the development of spoken language - in fact, their spoken language skill increased as more sign language was acquired; (2) deaf children’s language milestones were observed to follow the same trajectory as that of hearing children – this particular finding represents a social-cognitive environmental influence that underlies language acquisition, regardless of whether language is spoken or signed; and (3) access to a visual language in the home, such as a sign language, was also observed to reduce communication frustration in deaf children. We can draw insight from this in our current study in that communication and language skills are necessary for literacy, regardless of language modality.

Research on deaf children who use ASL has consistently shown associations between print literacy and ASL knowledge and proficiency level (Freel, Clark, Anderson, Gilbert, Musyoka, & Hauser, 2012; Strong and Prinz, 1997; Hoffmeister, 2000; Lange, Lane-Outlaw, Lange, & Sherwood, 2013; Hrastinski & Wilbur, 2016; Hermans, Knoors, Ormel, & Verhoeven, 2018). Freel et al. (2012) studied the impact of ASL proficiency, reading skills, and family characteristics on language and literacy development. They reported that ASL proficiency
positively correlated with English literacy, and that native signers\(^3\) had higher bilingual abilities in ASL and written English compared to non-native signers. In addition, higher levels of maternal education were related to more proficient bilingual abilities. However, the native signers in the study were from homes where parents had higher levels of education than the non-native signers.

Strong and Prinz (1997) compared the ASL and English literacy of deaf children who had either deaf parents or hearing parents, to examine whether ASL ability is related to development of English literacy skills over a 12-month period. Their data showed that, when controlling for age and cognitive ability, children with better ASL skills significantly outperformed those with weaker ASL skills in their English literacy. Relatedly, on assessments of both ASL and English literacy, deaf students with deaf mothers scored significantly higher than deaf students with hearing mothers. Strong and Prinz concluded that ASL skills allow for better acquisition of English literacy skills, and that English literacy ability promoted increased ASL skills, although other factors such as IQ and age influenced skill in both languages. Although ASL seems to have a major effect on English print literacy skills in deaf children, other environmental influences such as socioeconomic status also plays a role.

**SES and parental education.** Socioeconomic status (SES) has been shown to have significant effects on the development of literacy in spoken-language monolinguals and bilinguals (Droop & Verhoeven, 2003; Ransdell, 2012; White, 1982). In a longitudinal study, Hart & Risley (2004) studied vocabulary growth in families categorized according to SES. More

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\(^3\) To be classified as a native signer, the authors determined that participants had to have deaf parents and report that their acquisition of ASL began prior to age three years.
than 1,300 hours of interactions between parents and their children were analyzed. By four years of age, an average child in a higher status family was exposed to almost 45 million words; an average child in a middle-class family, 26 million words; and an average child in a family receiving welfare, only 13 million words. Furthermore, it has been reported that children who lived in poverty are three times more likely to drop out or fail to graduate than whose who never lived in poverty (Annie E. Casey Foundation, 2010).

Word exposure findings are mirrored in research on in-home book sharing. The average child growing up in a low-income family is exposed to only 25 hours of one-on-one reading time per year, whereas the average child growing up in a middle-class family is exposed to approximately 1,000 to 1,700 hours of one-on-one reading time per year (McQuillan, 1998). Those with higher income levels were able to invest more time reading with their child. Children with families living in impoverished areas have fewer opportunities to access resources such as high-quality day care, early education, health care, decent housing, food, clothing, and books. Additionally, the neighborhood these families are likely to live in are near schools that have limited resources and low-performing academics as a whole. As a result, low-income school-aged children have fewer opportunities for language and literacy growth compared to those children from higher income homes (Berk, 2009). Consequently, these low-income school age children are at risk for developing weaker academic skills and falling behind in reading achievement during the school years.

Researchers have debated whether SES has direct or indirect effects on literacy outcomes. The number of books in the home, amount of time parents read to their children, and the quality of conversation between parents and children are examples of literacy-mediating factors that are directly affected by SES. Alternatively, there is a pathway for an indirect effect
because research has shown that SES influences both first and second language fluency, themselves predictors of literacy outcomes.

SES also affects literacy development in deaf signing bilinguals. Twitchell, Morford, and Hauser (2015) investigated the effects of SES and ASL proficiency on English reading proficiency in deaf bilingual children and adults between the ages of 8 and 26 years. The found no association between SES and ASL proficiency, however, SES and ASL both predicted reading scores. In terms of vocabulary skills, one study documented low vocabulary levels in deaf students compared to those of their hearing peers (Paul, 2000). In contrast, Prezbindowski and Lederberg (2003) found that deaf children from deaf parents have a larger vocabulary in ASL compared to hearing children’s language vocabularies at 12 to 17 months of age. ASL and home literacy environment in high-SES families may be beneficial for the development of vocabulary and print literacy in deaf individuals.

Social Interaction in School

One challenge for the education of many deaf children is that deaf students need the ability to use their natural language and associate it with the written system (Padden & Ramsey, 1998) as well as to be able to socially interact. This is where an educational philosophy known as the bilingual-bicultural (Bi-Bi) approach might be beneficial. This approach began to emerge in schools during the late 1980s in the United States and in other countries such as Denmark (Hansen, 1990) and Sweden (Svartholm, 1993). The ASL/English Bi-Bi approach aims to support academic success and provide education to deaf students by emphasizing the co-development of English and ASL skills. The Bi-Bi model promotes the development of ASL as a vehicle for the acquisition of English literacy skills (Hoffmeister & Caldwell, 2014).
There is a large literature showing correlations between ASL and English skills for deaf children in BiBi programs (Freel, Clark, Anderson, Gilbert, Musyoka, & Hauser, 2012; Strong and Prinz, 1997; Hoffmeister, 2000; Lange, Lane-Outlaw, Lange, & Sherwood, 2013; Hrastinski & Wilbur, 2016; Hermans, Knoors, Ormel, & Verhoeven, 2018). Lange et al. (2013) compared the academic growth of deaf students who had been in a Bi-Bi program for at least 4 years with national norms based upon a database of test results mostly from hearing students. They also examined the effects of factors such as gender, parental hearing status, and secondary disability status on academic growth. Students who attended the Bi-Bi school for approximately eight years eventually caught up with and outperformed the hearing norms. The amount of time spent receiving an education in a Bi-Bi school allows for continual growth, therefore supporting the efficacy of these type of programs (Henner, Caldwell-Harris, Novogrodsky, & Hoffmeister, 2016). Parental hearing status was not a significant factor, and children with secondary disabilities showed a significantly lower performance in academic growth compared to those with hearing loss documented as their only disability. Hrastinski and Wilbur (2016) investigated language and background factors that influenced reading comprehension in deaf 6th to 11th grade students who used ASL and were enrolled in a Bi-Bi program. They hypothesized that deaf students with high ASL proficiency would perform better on English reading comprehension tasks and assessment of English language use than deaf students with low ASL proficiency. Other predictors included age at enrollment in the school, whether or not students had a cochlear implant (CI), speech and language impairment diagnosis, and home language. Based on school-based ASL assessment scores, students were split into two groups: highly proficient in ASL or not as highly proficient in ASL. For the most part, students were either from homes with one or both deaf parents who used ASL predominantly, or from homes with two hearing parents who
used English predominantly. Results showed that on standardized English reading comprehension and language use tests, the deaf students with more fluent ASL performed better than deaf students who were less fluent in ASL. Other factors such as home language or age at enrollment in the school did not contribute significantly to scores on English-related tests. This finding, that ASL proficiency is important for reading comprehension, was also reported by Novogrodsky, Caldwell-Harris, Fish, and Hoffmeister (2014). They concluded that ASL fluency appeared to be the strongest predictor of reading comprehension, above and beyond parental hearing status, which often/can be considered a proxy for home language.

Similar to previous research by Hrastinski and Wilbur (2016), the current study focuses on literacy growth within deaf children attending an ASL-English BiBi deaf school. However, this is the first study to look at longitudinal growth in 1st through 12th grade using school administrative data. We aim to answer two research questions: (A) does exposure to ASL in the home – prior to formal education – improve English literacy outcomes, and (B) does it matter whether parents are deaf ASL signers or hearing parents learning ASL?

We hypothesize that:

(1) Deaf children with signing parents (DCSP; those who reported signing at home prior to Bi-Bi school entry) will show higher literacy growth than those deaf children with non-signing parents (DCNSP);

(2) Within families who report signing with their deaf children, those deaf children with deaf signing parents (DCDSP) will show higher literacy growth than those deaf children with hearing signing parents (DCHSP).
Method

Data Set and Participants

The data set is curated and maintained by Matthew Dye and Peter Hauser at the National Technical Institute for the Deaf, and contains records for 778 deaf students who attended a K-12 deaf school located in the southwestern United States between the years of 2008 and 2018. The data set consists of several distinct subsets of data, each corresponding to different sources of information maintained by the school.

Student Summary Sheet

The Student Summary Sheet contains core demographic data for each individual child. From the Student Summary Sheet, the following variables were selected:

- `arc_id`: a unique identifier associated with each child
- `dob`: child’s date of birth
- `school_entry_date`: date of child’s enrollment in school
- `gender`: child’s gender, coded as male, female or non-binary
- `residency_status`: whether the child was a day student or resided at the school during the week
- `ethnicity`: child’s ethnic category as coded by the school

Due to researcher entry data error, one record was removed as a duplicate resulting in n=286 unique cases for which all requested was available.

Student Background Questionnaire: Family Background (SBGQ: Family)

The SBGQ contains data from a form that parents complete at the time of a child’s enrollment into the school. The responses therefore reflect the situation at each child’s
school_entry_date. From the SBGQ, one subset of data contains Family Background data, from which the following variables were selected:

   arc_id: a unique identifier associated with each child

   birth_mother_edu: birth mother’s highest academic achievement (no formal education, primary (K-5th), some high school (6th-12th), high school graduate, vocational training school, some college, college graduate, graduate degree, and doctoral degree

   birth_mother_occ: birth mother’s occupation at time of child’s enrollment

   birth_mother_deaf: birth mother hearing, deaf/hard-of-hearing, or unknown

   birth_father_edu: birth father’s highest academic achievement (no formal education, primary (K-5th), some high school (6th-12th), high school graduate, vocational training school, some college, college graduate, graduate degree, and doctoral degree

   birth_father_occ: birth father’s occupation at time of child’s enrollment

   birth_father_deaf: birth father hearing, deaf/hard-of-hearing, or unknown

The SBGQ: Family has 286 entries for which Student Summary Sheet data was also available. Data entry errors had resulted in some duplicates. After these were removed, there were n=273 unique cases.

SBGQ: History of Hearing Loss

The SBGQ also asked parents to provide information about the history of hearing loss for their child. From that data subset, the following variables were selected:

   arc_id: a unique identifier associated with each child
cause_hl: what was the child’s cause of hearing loss: unknown, hereditary/genetic, meningitis, seizures, hyperbilirubinemia, Waardenburg Syndrome, CMV, Maternal-Rubella, Goldenhar-Syndrome

age_aud_services: at what age (in months) did the child first received audiology services for hearing loss

age_has: at what age (in months) was hearing aids first introduced to the child

ci: whether or not the child has a cochlear implant

age_asl: at what age (in months) were hearing aids introduced to the child

parent_comm_type: communication method(s) mother and father use with their child at home: signs, fingerspells, gestures, speaks, and/or writes

The SBGQ: History of Hearing Loss has 284 entries for which Student Summary Sheet and Student Background Questionnaire data was available. Data entry errors had resulted in two duplicates. After this was removed, there were n=282 unique cases.

Audiology

The audiogram consisted of information on a child’s decibel (or dB) threshold, which is the unit of intensity used to describe hearing sensitivity, collected during the diagnostic hearing evaluation. The threshold is measured at different frequencies, ranging from low frequencies (250 Hz) to high frequencies (2000 Hz) in each ear. The following are categories for degree of hearing loss: mild hearing loss: 25 to 40 dB, moderate hearing loss: 40 to 55 dB, moderate-to-severe hearing loss: 55 to 70 dB, and severe hearing loss: 70 to 90 dB, profound loss: 90 dB or more.

arc_id: a unique identifier associated with each child

dBHLR500_1: dB threshold at 500 Hz for the right ear
dBHLR1000_1: dB threshold at 1000 Hz for the right ear

dBHLR2000_1: dB threshold at 2000 Hz for the right ear

dBHLL500_1: dB threshold at 500 Hz for the left ear

dBHLL1000_1: dB threshold at 1000 Hz for the left ear

dBHLL2000_1: dB threshold at 2000 Hz for the left ear

SATR_1: speech awareness threshold (SAT), lowest level a child can hear speech, for the right ear

SATL_1: speech awareness threshold (SAT), lowest level a child can hear speech, for the left ear

SFCI500_1: sound field with cochlear implant at 500 Hz

SFCI1000_1: sound field with cochlear implant at 1000 Hz

SFCI1500_1: sound field with cochlear implant at 1500 Hz

SFCI2000_1: sound field with cochlear implant at 2000 Hz

The Audiology data subset contained 265 records for which data from the subsets above was also available. One record was removed because of a missing arc_id, yielding n = 264 unique and identifiable records.

Psychological Diagnoses

Dr. Natasha Kordus and Dr. Peter Hauser, both licensed clinical neuropsychologists experienced in working with deaf children, reviewed all student records in the database and confirmed diagnosis with further review of psychological evaluations and assessment results.

arc_id: a unique identifier associated with each child
diagnosis_present: intellectual disability, motor difficulties, autism, visual impairment, specific language impairment: spoken English, emotional disturbance, anxiety, depression, CHARGE, other health impairment (cardiovascular, respiratory, or gastrointestinal syndromes or other related impairments), Duanes Syndrome, Moebius Syndrome, learning disability, and ADHD

The Psychological Diagnosis dataset contained 347 entries. Data was missing for two entries, resulting in a final total of n = 345 unique entries.

NWEA MAP Literacy

Test_RIT_score: This is the literacy RIT Score. The RIT scale is a Rausch Unit score that indicates the level of assessment where the child is performing correctly 50% of the time. We collated RIT scores from the fall and spring semesters for all children for each year that they were enrolled in the school.

The NWEA MAP Literacy data set contained RIT scores from 778 children. We removed children who were receiving special needs education at the time of MAP Literacy testing, and children for whom the above records were not available.

Combined Dataset

These datasets were combined on the basis of the arc_id variable, resulting in a total of 845 unique records. The following new variables were computed:

deaf_parent: if birth_mother_deaf = deaf or hard-of-hearing or birth_father_deaf = deaf or hard-of-hearing, then = 1, else = 0

age_at_school_entry_years: school_entry_date and dob were used to calculate each child’s age at school entry (in years)
ses_family: computed as the larger of (a) (mother’s SES occupation code*5) + (mother’s education code*3) or (b) (father’s SES occupation code*5) + (father’s education code*3)

pta_hl_better_ear: the average threshold at 500 Hz, 1000 Hz, and 2000 Hz for both right ear and left ear was calculated, and the lowest threshold (the better ear) was selected.

Exclusion Criteria

We excluded children who have not completed any MAP Literacy assessment, and also excluded those children who were in special needs classrooms at the time of MAP Literacy testing. In addition, we excluded children with a documented psychological diagnosis, resulting in a total of 178 unique and identifiable records.

Design

Aim (A): The initial analysis looked at change over time in MAP Literacy scores, comparing children with parents who reported signing at home (DCSF; parent_sign = 1) with children with parents who did not report signing at home (DCNSF; parent_sign = 0). See Table 1 for descriptive statistics and t-tests.

Aim (B): The second analysis included only those children with parents who reported signing with them prior to school entry (parent_sign = 1). Within this subset of data, MAP Literacy scores over time were compared for children with deaf parents (DCDSP; deaf_parent = 1) and those with hearing parents (DCHSP; deaf_parent = 0). See Table 2 for descriptive statistics and t-tests.
Statistical Analysis

In order to compare growth in MAP Literacy scores across groups, increasing complex linear mixed models were constructed using the `nlme` package within the `R` statistical computing environment.

For both aims, we initially constructed a simple no-growth model that predicts MAP Literacy scores with a fixed intercept:

\[(1) \quad X_i = \beta_{0i} + \varepsilon_i\]

\(X_i\) = predicted literacy score of the \(i^{th}\) child

\(\beta_{0i}\) = mean intercept for all children (fixed effect)

\(\varepsilon_i\) = residual for child \(i\)

We then extend the model to include a growth component based upon repeated measurements of literacy:

\[(2) \quad X_i = (\beta_{0i} + \beta_{1i}) + (\beta_{0i} + \beta_{2i}) + \varepsilon_i\]

\(X_i\) = predicted literacy score of the \(i^{th}\) child

\(\beta_{0i}\) = mean intercept for all children (fixed effect)

\(\beta_{02}\) = mean slope for all children (fixed effect)

\(\beta_{1i}\) = effect of intercept for child \(i\) (random effect)

\(\beta_{2i}\) = effect of slope for child \(i\) (random effect)

\(\varepsilon_i\) = residual for child \(i\)

Next, we construct multilevel models in order to test our hypotheses:

\[(3A) \quad X_i = (\beta_{0i} + \beta_{1i}(parent\_sign) + \beta_{1i}) + (\beta_{0i} + \beta_{1i}(parent\_sign) + \beta_{2i}) + \varepsilon_i\]
\( X_i = \) predicted literacy score of the \( i^{th} \) child

\( \beta_{01} = \) mean intercept for all children (fixed effect)

\( \beta_{11} = \) effect of parent_sign on intercept (fixed effect)

\( \beta_{02} = \) mean slope for all children (fixed effect)

\( \beta_{12} = \) effect of parent_sign on slope (fixed effect)

\( d_{1i} = \) effect of intercept for child \( i \) (random effect)

\( d_{2i} = \) effect of slope for child \( i \) (random effect)

\( \epsilon_i = \) residual for child \( i \)

\( \text{parent\_sign}: 0 = \text{no sign, 1 = sign} \)

In this model, we interpret the estimate of \( \beta_{11} \) as the effect of parents signing with the child on MAP Literacy scores at school entry (Grade 1). We interpret the estimate of \( \beta_{12} \) as the effect of parents signing with the child on growth in MAP Literacy scores.

For Aim B, the multilevel model is:

\[
(3B) \quad X_i = (\beta_{01} + \beta_{11}(\text{deaf\_parent}) + d_{1i}) + (\beta_{02} + \beta_{12}(\text{deaf\_parent}) + d_{2i}) + \epsilon_i
\]

\( X_i = \) predicted literacy score of the \( i^{th} \) child

\( \beta_{01} = \) mean intercept for all children (fixed effect)

\( \beta_{11} = \) effect of deaf_parent on intercept (fixed effect)

\( \beta_{02} = \) mean slope for all children (fixed effect)

\( \beta_{12} = \) effect of deaf_parent on slope (fixed effect)

\( d_{1i} = \) effect of intercept for child \( i \) (random effect)

\( d_{2i} = \) effect of slope for child \( i \) (random effect)

\( \epsilon_i = \) residual for child \( i \)
deaf_parent: 0 = no DHH parents, 1 = at least one DHH parent

Covariates

Based upon the results of prior research, there are three important covariates of interest (ses_family, age_asl, and age_at_school_entry_years), which are introduced into the multilevel model as follows in order to account for their influence on MAP Literacy scores at school entry for both Aim A and Aim B:

\[(4, 5, 6) X_i = (\beta_{01} + \beta_{11}(\text{deaf_parent}) + \beta_{21}(\text{covariate}) + d_{1i}) + (\beta_{02} + \beta_{12}(\text{deaf_parent}) + d_{2i}) + \varepsilon_i \]

\(X_i\) = predicted literacy score of the \(i^{th}\) child

\(\beta_{01}\) = mean intercept for all children (fixed effect)

\(\beta_{11}\) = effect of deaf_parent on intercept (fixed effect)

\(\beta_{21}\) = effect of covariate on intercept (random effect)

\(\beta_{02}\) = mean slope for all children (fixed effect)

\(\beta_{12}\) = effect of deaf_parent on slope (fixed effect)

\(d_{1i}\) = effect of intercept for child \(i\) (random effect)

\(d_{2i}\) = effect of slope for child \(i\) (random effect)

\(\varepsilon_i\) = residual for child \(i\)

deaf_parent: 0 = no DHH parents, 1 = at least one DHH parent
Results

Aim A: Parent sign

Table 3 shows results from the multi-level mixed modeling for Aim A. Figure 3 shows the observed data (MAP literacy scores). Model 1 (1,247 observations\(^4\)) is a simple no-growth model that predicts MAP Literacy scores with a fixed intercept \[X_i = \beta_{01} + \varepsilon_i\]. The mean intercept (MAP literacy score at 1\(^{st}\) grade) for all children in the no growth model was \(\beta_{01} = 180.49\) (\(p < .001\)) The AIC, the goodness of fit between the model and observed data across all children, was 10,145.36.

The model was then expanded to include a growth component (1,195 observations\(^5\)) based upon repeated measurements of literacy across semesters \[X_i = (\beta_{01} + d_{1i}) + (\beta_{02} + d_{2i}) + \varepsilon_i\]. The mean intercept (MAP literacy score at 1\(^{st}\) grade) for all children in the growth model was \(\beta_{01} = 157.38\) (\(p < .001\)), and the mean slope (improvement at each grade) for all children was \(\beta_{02} = 4.14\), \(p < .001\). The fixed effect of grade was significantly different from 0, indicating growth in MAP literacy scores over time. The AIC dropped from 10,145.36 to 8,427.72, suggesting that this model was a much more accurate description of the observed data than the previous intercept-only model.

We next constructed a multi-level model (1,137 observations) to test our hypothesis concerning the effect of having signing parents on literacy at 1\(^{st}\) grade and subsequent literacy growth \[X_i = (\beta_{01} + \beta_{11}(parent\_sign) + d_{1i}) + (\beta_{02} + \beta_{12}(parent\_sign) + d_{2i}) + \varepsilon_i\]. This is

\(^4\) One MAP literacy score from one semester for one child = one observation.

\(^5\) The number of observations were insufficient to compute slopes for some children, who were therefore excluded from this model.
similar to the growth model above, but the effect of having a parent who signs on the fixed
intercept and fixed slope components is also included. The mean intercept (MAP literacy score at
1\textsuperscript{st} grade) for all children in the multi-level model was $\beta_{01} = 146.75$ (p < .001), and the effect of
having a parent who signs on MAP literacy score at 1\textsuperscript{st} grade was $\beta_{11} = 12.56$ (p < .001). There
was a 4.17 ($\beta_{02}$) point gain per year (p < .001) and the effect on growth of having a parent who
signs ($\beta_{12} = 0.23$) was not statistically significant. AIC dropped from 8,427.72 to 7.926.01 so there
is improved goodness of fit, suggesting that inclusion of parent signing behavior is an important
component for predicting MAP literacy scores.

We expanded on the multi-level model to control for the effects of SES (676
observations) on the effect of having a parent who signs on MAP literacy score at 1\textsuperscript{st} grade
$[\{(\beta_{01} + \beta_{11}(parent\_sign) + \beta_{21}(ses\_family) + d_{1i}) + (\beta_{02} + \beta_{12}(parent\_sign) + d_{2i}) + \epsilon_{i}\}]$.

The mean intercept (MAP literacy score at 1\textsuperscript{st} grade) for all children was $\beta_{01} = 151.23$ (p < .001),
and the effect of having a parent who signs on MAP literacy score at 1\textsuperscript{st} grade was $\beta_{11} = 6.23$ (p
> .05). There was a 4.05 ($\beta_{02}$) point gain per year (p < .001) and the effect of having a parent
who signs on literacy growth ($\beta_{12} = 0.15$) was not significant. Including SES as a covariate
attenuated the observed effect of having a parent who signs on MAP literacy scores at 1\textsuperscript{st} grade.
AIC dropped from 7.926.01 to 4,720.86, although we were missing SES data resulting in a large
decrease in the number of observations and preventing a direct comparison of AIC values. To
determine whether the attenuation of the parent signing effect reflected a true effect of SES or
was simply due to reduced sample size, we constructed another model using the same children
but without including SES as a covariate (964 observations). The mean intercept for this model
(MAP literacy score at 1\textsuperscript{st} grade) for all children was $\beta_{01} = 150.10$ (p < .001), and the effect of
having a parent who signs on MAP literacy score at 1st grade (β₁₁ = 8.20) was not significant. There was a 4.08 (β₀₂) point gain per year and the effect of having a parent who signs on MAP literacy score was β₁₂ = 0.16. AIC in the previous model with SES as a covariate was 4,720.86 and this was not much different here (AIC 4,716.88). This suggests that in the SES covariate model, the effect of parental signing on MAP literacy score at 1st grade disappeared due to the decrease in sample size (and consequently the precision of the β₁₂ estimate) and not due to the inclusion of SES as a covariate.

Next, we controlled for the effect of age of ASL exposure (1,137 observations) in the multi-level model. The mean intercept (MAP literacy score at 1st grade) for all children was β₀₁ = 143.79 (p < .001), and the effect of having a parent who signs on MAP literacy score at 1st grade was β₁₁ =14.93 (p < .001). There was a 4.48 (β₀₂) point gain per year and the effect of having a parent who signs (β₁₂=-0.27) remained not statistically significant after controlling for age of ASL exposure. The AIC dropped from 7.926.01 to 6,726.83.

Finally, we controlled for the effect of age of school entry (964 observations) in the multi-level model. The mean intercept (MAP literacy score at 1st grade) for all children was β₀₁ = 150.70 (p < .001), and the effect of having a parent who signs on MAP literacy score at 1st grade was β₁₁ =9.90 (p < .001). There was a 3.88-point gain per year and the effect of having a parent who signs (β₁₂=-0.35) remained not statistically significant after controlling for age of school entry. AIC dropped slightly from 7.926.01 to 7, 912.02.

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⁶ Note: covariates were introduced individually into separate models in order to maintain statistical power.
For the final model we removed the $\beta_{12}$ parameter because it was not statistically significant for any model (1,137 observations). Age of exposure to ASL was retained as a covariate, as its inclusion resulted in a large decrease in AIC. The final model (shown in Figure 4) was:

$$X_i (parent\_sign = 1) = 158.72 + (4.27*[grade-1]) + d_{1i} + d_{2i} + \epsilon_i$$

$$X_i (parent\_sign = 0) = 144.04 + (4.27*[grade-1]) + d_{1i} + d_{2i} + \epsilon_i$$

**Aim B: Deaf parent**

Table 4 reports results from the multi-level mixed modeling for Aim B. Figure 5 shows the observed data (MAP literacy score). Model 1 (904 observations) is a simple no-growth model that predicts MAP Literacy scores with a fixed intercept $[X_i = \beta_{01} + \epsilon_i]$. The mean intercept (MAP literacy score at 1st grade) for all children in the no growth model was $\beta_{01} = 183.32$ ($p < .001$). The AIC, the goodness of fit between the model and observed data on all children, was 7288.81.

The model was then expanded to include a growth component (875) based upon repeated measurements of literacy across semesters $[X_i = (\beta_{01} + d_{1i}) + (\beta_{02} + d_{2i}) + \epsilon_i]$. The mean intercept (MAP literacy score at 1st grade) for all children in the growth model was $\beta_{01} = 159.03$ ($p < .001$) and the mean slope (improvement at each grade) for all children was $\beta_{02} = 4.42$ ($p < .001$). The fixed effect of grade was significantly different from 0, indicating growth in MAP literacy scores over time. The AIC dropped from 7288.81 to 6089.61, suggesting that this model was a much more accurate description of the observed data than the previous intercept-only model.

We next constructed a multi-level model (846 observations) to test our hypothesis concerning the effect of having a deaf parent on literacy at 1st grade and subsequent literacy.
growth [$X_i = (\beta_{01} + \beta_{11}(\text{deaf\_parent}) + d_{1i}) + (\beta_{02} + \beta_{12}(\text{deaf\_parent}) + d_{2i}) + \epsilon_i]$. The mean intercept (MAP literacy score at 1st grade) for all children in the multi-level model was $\beta_{01} = 148.59$ (p < .001) and the effect of having a deaf parent on MAP literacy score at 1st grade was $\beta_{11} = 17.74$ (p < .001). There was a 3.97 ($\beta_{02}$) point gain per year for children with hearing signing parents, and a 5.00 ($\beta_{02} + \beta_{12}$) point gain per year for those with deaf parents (p=.03).

The AIC dropped from 6089.61 to 5869.87 so there is improved goodness of fit, suggesting that inclusion of parental hearing status is an important component for predicting MAP literacy scores.

We expanded on the multi-level model to control for the effects of SES (486 observations) on the effect of having a deaf parent on MAP literacy score at 1st grade [( $\beta_{01} + \beta_{11}(\text{deaf\_parent}) + \beta_{21}(\text{ses\_family}) + d_{1i}) + (\beta_{02} + \beta_{12}(\text{deaf\_parent}) + d_{2i}) + \epsilon_i]$. The mean intercept (MAP literacy score at 1st grade) for all children was $\beta_{01} = 147.47$ (p < .001), and the effect of having a deaf parent on MAP literacy score at 1st grade was $\beta_{11} = 21.97$ (p < .001). There was a 3.86 ($\beta_{02}$) point gain per year (p < .001) and the effect of having a deaf parent on MAP literacy growth ($\beta_{12} = 0.82$) was not significant after controlling for SES. AIC dropped from 5869.87 to 3.380.67 although we were missing SES data resulting in a large decrease in the number of observations, preventing a direct comparison of AIC values. To determine whether the attenuation of the parent signing effect reflected a true effect of SES or was simply due to reduced sample size, we constructed another model using the same students but without including SES as a covariate. The mean intercept for this model (MAP literacy score at 1st grade) for all children was $\beta_{01} = 147.64$ (p < .001), and the effect of having a deaf parent on MAP literacy score at 1st grade was $\beta_{11} = 21.94$ (p < .001). There was a 3.94 ($\beta_{02}$) point gain per year
and the effect of having a deaf parent on literacy growth was $\beta_{12} = 0.79$. AIC in the previous model with SES as a covariate was 3,380.67 and this was not much different here (AIC 3,376.13). This model suggests that in the SES covariate model, the effect of parental hearing status on literacy RIT scores at 1st grade disappeared due to the decrease in sample size (and consequently the precision of the $\beta_{12}$ estimate) and not due to the inclusion of SES as a covariate.

Next, we controlled for the effect of age of ASL exposure (747) in the multi-level model. The mean intercept (MAP literacy score at 1st grade) for all children was $\beta_{01} = 148.11$ (p < .001), and the effect of having a deaf parent on MAP literacy score at 1st grade was $\beta_{11} = 18.81$ (p < .001). There was a 3.80 ($\beta_{02}$) point gain per year and this was 1.15 points larger for those with deaf parents (p < .05). The deaf parent effect remained after controlling for age of ASL exposure. The AIC dropped from 5,869.87 to 5,187.60.

Finally, we controlled for the effect of age of school entry (846) in the multi-level model. The mean intercept (MAP literacy score at 1st grade) for all children was $\beta_{01} = 149.98$ (p < .001), and the effect of having a deaf parent on MAP literacy score at 1st grade was $\beta_{11} = 16.56$ (p < .001). There was a 3.84-point gain per year and this was 1.03 points larger for those with deaf parents (p < .05). The deaf parent effect remained after controlling for age of school entry. The AIC dropped slightly from 5869.87 to 5859.95.

For Aim B, the final model (shown in Figure 6) was the full multi-level model that included age of exposure to ASL as a covariate.

$$X_i(deaf\_parent = 1) = 166.92 + (4.95 \times \text{grade-1}) + d_{1i} + d_{2i} + \epsilon_i$$
$$X_i(deaf\_parent = 0) = 148.11 + (3.80 \times \text{grade-1}) + d_{1i} + d_{2i} + \epsilon_i$$
Correlational Analyses

We computed correlational analyses to determine the relationships between individual slope \((d_{1i})\) and growth \((d_{2i})\) estimates and the covariates used in the growth modeling \((\text{age of entry to school, age of ASL exposure, age of first audiology services, SES})\).

**Age of Entry to School**

The intercept (projected MAP score at 1\textsuperscript{st} grade) is higher if the student enters school at an earlier age. This relationship is statistically significant \((n=67, r= -0.0298, p < .05)\). However, individual growth on the MAP RIT score did not significantly correlate with age of entry to school \((n=67, r= -0.058, p > .05)\).

**Age of First Access to Audiological Services**

The intercept (projected MAP score at 1\textsuperscript{st} grade) is higher if the student received audiology services received at an earlier age. This relationship is not statistically significant \((n=51, r= -0.070, p > .05)\). However, individual growth on the MAP RIT score significantly correlated with age of audiology services received \((n=51, r= -0.321, p < .05)\).

**Age of ASL Exposure**

The intercept (projected MAP score at 1\textsuperscript{st} grade) is higher if the student was exposed to ASL earlier, but this relationship was not statistically significant \((n=55, r= -0.202, p > .05)\). In addition, individual growth on the MAP RIT score also did not significantly correlate with earlier age of ASL exposure \((n =55, r = -0.156, p > .05)\).

**Socio-Economic Status**
There was no correlation found between mean intercept and SES when accounting for parental hearing status effect ($n=45$, $r=0.185$, $p > .05$) and also no correlation noted for individual growth and SES when accounting for parental hearing status ($n=45$, $r=0.037$, $p > .05$).
**Discussion**

Overall for our first Aim (A), when we looked at parents who report signing, those children had a 2.5-year advantage in terms of English literacy when they arrive at the school. At face value, this suggests that exposure to sign language before formal schooling leads to positive literacy outcomes. Once deaf children are in school, their literacy growth (4.3 points per grade) appears to be the same for both groups (signing parents: DCSP and non-signing parents: DCNSP), suggesting that they benefit equally from education in ASL at the school. However, we are not sure what their emergent literacy skills looked like prior to school entry and more importantly, we do not know what the quality of parental signing looks like in the home. Aim (B) allows us to address the quality of signing by selecting the signing group and comparing those deaf children from deaf signing parents (DCDSP) and those from hearing signing parents (DCHSP). Parental hearing status can be considered a proxy for the home language being ASL, as well as for exposure to deaf culture.

When we looked at signing parents, deaf children with deaf parents had a 4.5-year advantage in terms of their English literacy over those with hearing parents when they arrived at the school. On the face of it, this suggests that exposure to sign language from deaf parents before formal schooling leads to positive literacy outcomes. In addition, DCDSP gain an extra 1.1 literacy points per year over DCHSP, representing an additional 3-year advantage by the time of high school graduation. SES or age of ASL exposure did not explain these effects. However, because DCDSP are enrolling into the school with an advantage in their literacy performance, this indicates literacy development for deaf children begins in the home before formal schooling. Using a social cultural framework to explain this finding, DCDSP may have access to better quality ASL and higher quality interaction through ASL than do DCHSP. In addition, deaf
parents are naturally able to teach deaf cultural values and share similar experiences with their deaf child. In regard to this, it is worth noting that only 14% of the children from deaf parents were residential students, compared to hearing parents where 45% of deaf children were residential students. Given this fact, it is possible that the DCDSP have more opportunities for parent-child interaction at home. Future research should further investigate whether day or residential status for deaf children from hearing parents impacts their literacy growth while attending a Bi-Bi school.

Although the effect of parental signing appeared to be driven by SES, the model that included SES had a lot of missing data that reduced statistical power and the precision of parameter estimates considerably. The role of SES in driving the apparent parental signing effect cannot therefore be established with this data set. Additionally, according to correlational analyses, there was no relationship observed between SES and literacy growth in deaf children who attended a Bi-Bi school. While our study did not find a role in SES, previous studies show SES is still an important factor for assessing literacy development in deaf children attending a Bi-Bi school (Droop & Verhoeven, 2003; Hart & Risley, 2004; Prezbindowski & Lederberg, 2003; Ransdell, 2012; White, 1982), therefore, SES should still be taken into consideration in future research examining deaf children’s literacy growth.

Early development of literacy skills in children are influenced by a wide range of possible factors such as cognitive processes, amount of language input, the number of books in the home, the amount of time child spends reading, and the amount of time parents spend reading to their child. The child needs to be both exposed to print, and to have the linguistic and cognitive resources necessary to understand it. Most of these factors take place in the home before entering school and our results suggest that parents who sign can promote their deaf child’s cognitive
processes, language input, and literacy practices more than non-signing parents, most likely due to the spoken language not being accessible.

Henner et al.(2016) found students who attended a Bi-Bi school for approximately eight years eventually caught up with and outperformed the hearing norms in literacy and concluded that the amount of time spent receiving an education in a Bi-Bi school allows for continual growth, therefore supporting the efficacy of these type of programs. However, while this study also looked at deaf children in a Bi-Bi school, we modelled the effect of age of entry as a random variable. That is, we accounted for it in the model at an individual level, and we cannot make claims about whether early entry has a group level (“fixed”) effect. However, there was a significant relationship between a higher projected MAP reading score at 1st grade and earlier age of school entry whereas there was no relationship between individual literacy growth and age of school entry. In our sample, age of school entry was earlier for DCDSP (mean = 6 years old) than for DCHSP (mean = 10 years old). The earlier age of entry to school in DCDSP is interesting in itself. Based on our dataset, Deaf parents send their deaf children to a deaf school at an earlier age. We propose that the similarities between home and school language (ASL) and culture (Deaf environment) benefits deaf children in terms of arriving at school with prior English literacy skills which better prepares them for academic success. This is especially important given what we know about the process of cognitive development; exposing young children to accessible language and culture promotes the literacy experiences required for them to become good readers later in life. The findings of Lonigan et al. (2000) support this: in their study, emerging literacy skills developed prior to school entry was one of the most important predictors of how well children read once exposed to formal literacy education. It could be that DCDSP are accessing early emerging literacy experiences including conversations, stories, and
interactive reading. During these practices, deaf parents may be more effective in scaffolding their deaf child’s skills. In other words, some deaf children may have skills they can perform independently, while other skills can be performed only with assistance from their deaf parents. According to Vygotsky, skills that can be performed with assistance are known to be within an individual’s ZPD and the scaffolding provided by deaf parents is helping them attain independence.

We can see in our models that the groups differ in terms of their literacy growth rates – it is not clear whether this is due to reduced gains during the semester or whether the groups differ in the extent to which their literacy scores drop from spring to fall (summer setback; Heyns, 1978). Within our sample, we observed that DCHP enter the deaf school at a significantly later age than DCDP. Although this data is interesting, we cannot confirm why this occurs. It may be because they are struggling in mainstream programs and then transfer in later, perhaps as a result of social-cultural barriers or even due to additional disabilities the deaf students may have. The majority of deaf students in mainstream settings will not know a sign language and often information is not directly accessible to the student.

Hearing parents may decide that their deaf child would be exposed to better language models in residence at the school compared to what they can themselves provide at home. In our sample, we note discrepancies in the number of those who are day or residential students from hearing or deaf parents. In the DCDSP group, 86% of deaf students were residential students whereas in the DCHSP, only 55% of deaf students were residential students. This discrepancy prevents us from making direct comparisons between residential dormitory students and day commuter students.
There was a relationship between early entry to the school and predicted literacy score at 1st grade when accounting for parental hearing status. There was no relationship between early age of entry to the school and individual literacy growth. Regardless of age of entry, all deaf children maintained growth in literacy, potentially supporting the hypothesis that they benefit from being in a deaf Bi-Bi school environment.

There was no relationship between predicted literacy score at 1st grade and receiving earlier audiology services, while there was a relationship between individual literacy growth and receiving audiology services earlier. It’s difficult to interpret this when we don’t have data on what type of audiology services were received. However, earlier audiology services implicate an earlier detection, which leads to early intervention services. As stated before, early intervention is crucial for cognitive development.

Interestingly, earlier age of ASL exposure was not related to predicted literacy score at 1st grade, nor to individual growth. One might interpret age of ASL exposure as irrelevant to the growth of literacy skills. However, previous studies suggest that a more likely interpretation is that parents and deaf children in our sample have a lot of variability in ASL experience and quality of ASL exposure, which is a confound in itself. Future studies should collect information on the quality of ASL and the quality of parental signing experience for deaf children with hearing parents.

There was no relationship between predicted literacy score at 1st grade and SES when accounting for parental hearing status effect. Individual literacy growth also did not relate to SES. See limitations for discussion of reduction in data on SES.
Limitations

There were apparent systematic demographic differences between our comparison groups. Signing parents on average had an SES composite of 37 while non-signing parents had a SES composite of 21. It is also important to note that our sample had an imbalance of ethnicity within our groups (DCSP: Hispanic 47.2%, African American 7.9%, Asian 0.78%, Filipino 2.4%, White 41.7%; DCNSP: Hispanic 85.4%, African American 7.3%, Samoan 2.4%, White 4.9%; DCDSP: Hispanic 31%, African American 2.8%, Filipino 1.4%, White 64.8%; DCHSP: Hispanic 71.2%, African American 15.4%, Asian 1.9%, Filipino 3.8%, White 7.7%). This is interesting to consider because a major proportion of signers in our hearing signing parent group are Hispanic (71.2%). With diverse ethnic groups, deaf children’s language and social interactions in the homes may vary due to cultural differences.

There were reductions in sample size in our multi-level modeling when including covariates with many missing values. For example, when including SES as a covariate in Aim A, not only did the estimate for the magnitude of the parameter decrease, the precision of that estimate was also wider. This limited our ability to determine whether or not factors such as SES were indeed responsible for apparent parental signing effects. We can also not be sure that SES data is truly missing at random. Unemployed parents or those with menial jobs or a lack of formal education may have been less likely to share that information due to social desirability effects.

It is important to consider that when parents reported ‘yes’ they sign with their child at home, the school has no available data on parents’ levels of ASL proficiency. Often, hearing signing parents are learning a sign language at the same time as their deaf children; therefore, their signing skills are not at the same level as those of deaf signing parents. This limits how we
interpret our findings because we do not have a measure of parental sign skill, and we cannot assume when a parent responds ‘yes’ to signing at home that they sign fluently. Ideally, a study would attempt to address this limitation by splitting groups based on parents’ signing skills. However, to date, there are no standardized parental ASL assessments available. It is also important to note that the children in this study are “nested” within classrooms. This information is not available in the data set, and thus we could not account for systematic variability attributable to this.

Additionally, it has been argued that standardized test scores provide no information about the underlying literacy processes for deaf readers. Ewoldt (1981) argues that these tests only provide information about how well or how poorly deaf children perform when tested. Test scores are also hard to interpret because they have not yet been standardized based on a group of deaf individuals (Brill, 1971). While the validity of MAP norms for hearing children has been established (NWEA, 2018), the validity of the test with deaf children has yet to be explored. This is important because we do not know if the test appropriately measures knowledge for deaf children with secondary disabilities and diverse language backgrounds, such as students who only recently started learning ASL and/or English.

Overall findings support the importance of ASL in literacy achievement for deaf students in an ASL–English Bi-Bi program. The majority of deaf students in the ASL-English Bi-Bi program showed growth in literacy skills every year they were in the school. We did not compare deaf students in our sample to hearing norms; rather we focused on comparing how much deaf students are developing in their literacy performance. As noted, the norms for the MAP are established based on hearing children’s performance and this would not be a fair comparison for deaf children.
We took age of ASL exposure into account when looking at MAP literacy scores in 1st grade. There were significant differences in age of ASL exposure for children from deaf parents compared to those with hearing parents. While early age of ASL exposure was not related to predicted literacy score and growth, this doesn’t necessarily mean early age of ASL exposure is not relevant for promoting literacy skills in home prior to formal schooling. One potential factor that was not tested by our data concerns the effect of the quality of parent-child communication (as distinct from the language of communication) on language acquisition of English or ASL. A study by Lou, Strong, and DeMatteo (1991) supports this notion and states the possible importance of having consistent language input (regardless of language type) on various academic and cognitive outcomes. It is clear that there is something happening in the DCDSP homes prior to school entry that is contributing to their advantage of literacy performance when they enter formal schooling.

Conclusion

To our knowledge, the current study is the first to use longitudinal, archival data to examine literacy growth in deaf children attending ASL-English bilingual (Bi-Bi) school. This paper examined pathways by which ASL can boost English print literacy: language development and cultural development as explained by Vygotsky’s social cultural theory of development. We use Vygotsky’s theory to frame the quality of language and social and cultural interaction a deaf child receives as factors that explain variability in English print literacy, especially prior to formal schooling.

We asked (1) whether deaf children with signing parents would show higher literacy growth than those deaf children with non-signing parents and (2) if deaf children with deaf signing parents would show higher literacy growth than those deaf children with hearing signing
parents. In contrast to what we expected, deaf children attending a deaf Bi-Bi school showed a similar rate of literacy growth regardless of signing and parental hearing status. However, deaf children from signing parents were ahead almost 3 years in literacy skills at the time of school entry compared to deaf children with non-signing parents. Deaf children from deaf, signing parents were ahead approximately 5 years in literacy skills at the time of school entry. While literacy growth during deaf children’s time at the deaf Bi-Bi school is similar, deaf children with deaf parents arrived at school with an advantage.

Our study extends support for the notion that deaf parents expose their deaf child to accessible social and cultural interaction at home prior to enrollment in ASL-English Bi-Bi schools, and that these interactions promote English print literacy. Accessing a similarly enriched environment with desirable Deaf cultural interaction may be challenging for deaf children from homes with hearing signing parents. Hearing signing parents may not have the Deaf cultural knowledge and interactions with Deaf culture and communities required to provide the resources important for print literacy development. Prior research substantiates the notion that use of ASL with deaf children from birth can promote success in language development, vocabulary, and literacy skills similar to typical developing hearing children (Freel, et. al., 2012; Hoffmeister, 2000; Lange, et. al., 2013; Hermans, et. al., 2018; Hrastinski & Wilbur, 2016; Hermans, et. al., 2018; Paul, 2000; Prezbindowski & Lederberg, 2003; Strong & Prinz, 1997; Twitchell et al., 2015).

Further evidence from the current study suggests that deaf children with hearing signing parents could benefit from more interventions that incorporate Deaf cultural resources and development of ASL skills. More importantly, in-home interventions for hearing parents that incorporate a deaf role model teaching Deaf cultural literacy practices, fostering parent-child
interactions, and exposing parents to resources is crucial for the development of print literacy skills in deaf children.
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Table 1: *Aim (A): Descriptive Statistics and t-test*

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*Note:* p < .05*, p < .01**, p < .001***. Age of ASL exposure and first access to audiology services is in months. Age at school entry is in years. There are statistically significant differences between signing parents and non-signing parents in family SES and student's age (in years) at school entry. We are missing information (n=4) on parental hearing status.
Table 2: *Aim (B): Descriptive Statistics and t-test*

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*Note:* p < .05*, p < .01**, p < .001***. Age of ASL exposure and first access to audiology services is in months. Age at school entry is in years. There are statistically significant
differences between deaf parents and hearing parents in student’s age (in months) of first ASL exposure and student’s age (in years) at school entry.

Table 3: *Aim (A): Multi-level Mixed Model*

<table>
<thead>
<tr>
<th></th>
<th>No Growth (1)</th>
<th>Growth (2)</th>
<th>Multi-Level Model (3)</th>
<th>MLM w/SES</th>
<th>MLM w/o SES</th>
<th>MLM w/ASL</th>
<th>MLM w/School Entry</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_{01}$</td>
<td>180.49***</td>
<td>157.38***</td>
<td>146.75***</td>
<td>151.23***</td>
<td>150.10***</td>
<td>143.79***</td>
<td>150.70***</td>
<td>144.04***</td>
</tr>
<tr>
<td>$\beta_{11}$</td>
<td></td>
<td></td>
<td>12.56***</td>
<td>6.23</td>
<td>8.20</td>
<td>14.93***</td>
<td>9.90***</td>
<td>14.68***</td>
</tr>
<tr>
<td>$\beta_{02}$</td>
<td></td>
<td></td>
<td>4.14***</td>
<td>4.17***</td>
<td>4.05***</td>
<td>4.08***</td>
<td>4.48***</td>
<td>3.88***</td>
</tr>
<tr>
<td>$\beta_{12}$</td>
<td></td>
<td></td>
<td>0.23</td>
<td>0.15</td>
<td>0.16</td>
<td>-0.27</td>
<td>0.35</td>
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</tr>
<tr>
<td>Observations</td>
<td>1,247</td>
<td>1,195</td>
<td>1,137</td>
<td>676</td>
<td>964</td>
<td>1,137</td>
<td>964</td>
<td>1,137</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-5,069.68</td>
<td>4,207.86</td>
<td>-3,955.00</td>
<td>-2,349.43</td>
<td>-2,350.44</td>
<td>-3,352.41</td>
<td>-3,945.01</td>
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<tr>
<td>AIC</td>
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<td>4,716.88</td>
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<td>6,725.03</td>
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<tr>
<td>BIC</td>
<td>10,160.75</td>
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<td>7,966.30</td>
<td>4,770.54</td>
<td>4,753.01</td>
<td>6,780.41</td>
<td>7,967.42</td>
<td>6,773.75</td>
</tr>
</tbody>
</table>

*Note: *p<0.1; **p<0.05; ***p<0.01. Level 0: $\beta_{01}$ = Intercept, $\beta_{02}$ = Slope; Level 1: $\beta_{11}$ = effect of parental signing on intercept, $\beta_{12}$ = effect of parental signing on slope*

Table 4: *Aim (B): Multi-level Mixed Model*

<table>
<thead>
<tr>
<th></th>
<th>No Growth</th>
<th>Growth</th>
<th>Multi-Level Model</th>
<th>MLM w/SES</th>
<th>MLM w/o SES</th>
<th>MLM w/ASL</th>
<th>MLM w/School Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_{01}$</td>
<td>183.33***</td>
<td>159.03***</td>
<td>148.59***</td>
<td>147.47***</td>
<td>147.64***</td>
<td>148.11***</td>
<td>149.98***</td>
</tr>
<tr>
<td>$\beta_{11}$</td>
<td></td>
<td></td>
<td>17.74***</td>
<td>21.97***</td>
<td>21.94***</td>
<td>18.81***</td>
<td>16.56***</td>
</tr>
<tr>
<td>$\beta_{02}$</td>
<td></td>
<td></td>
<td>4.42***</td>
<td>3.97***</td>
<td>3.86***</td>
<td>3.94***</td>
<td>3.80***</td>
</tr>
<tr>
<td>$\beta_{12}$</td>
<td></td>
<td></td>
<td>1.03**</td>
<td>0.82</td>
<td>0.79</td>
<td>1.15**</td>
<td>1.03**</td>
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<td>904</td>
<td>875</td>
<td>846</td>
<td>486</td>
<td>486</td>
<td>747</td>
<td>846</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-3,641.41</td>
<td>-3,038.81</td>
<td>-2,926.93</td>
<td>-1,679.33</td>
<td>-1,680.07</td>
<td>-2,582.80</td>
<td>-2,918.98</td>
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<tr>
<td></td>
<td>AIC</td>
<td>BIC</td>
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<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>0</td>
<td>7,288.81</td>
<td>7,303.23</td>
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<td></td>
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<tr>
<td>1</td>
<td>6,089.61</td>
<td>6,118.26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>5,869.87</td>
<td>5,907.79</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3,380.67</td>
<td>3,426.71</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3,376.13</td>
<td>3,409.62</td>
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<tr>
<td>5</td>
<td>5,187.60</td>
<td>5,238.37</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5,859.95</td>
<td>5,912.10</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: *p<0.1; **p<0.05; ***p<0.01. Level 0: beta_01= Intercept, beta_02= Slope; Level 1: beta_11= effect of parental hearing on intercept, beta_12= effect of parental hearing on slope
Figures

**Figure 1.** Vygotsky’s Zone of Proximal Development

This diagram shows Vygotsky’s theory about the interaction between language, culture, and cognitive development (Miller, 2002).

**Figure 2.** Vygotsky’s Sociocultural Theory

This diagram shows Vygotsky’s theory about the interaction between language, culture, and cognitive development (Miller, 2002).
Figure 3. Aim (A): Observed Data

Note: This figure represents each student’s actual observed RIT score from signing parents (1) and non-signing parents (0)
Figure 4. Aim A: Predicted Growth

Note: This model shows the predicted literacy growth based off the actual score for each individual from signing parents (1) and non-signing parents (0). Bold lines represent the mean growth trajectories for the groups.
Figure 5. Aim B: Observed Data

Note: This figure represents each student’s actual observed RIT score from deaf parents (1) and hearing parents (0)

Figure 6. Aim B: Predicted Growth
Note: This model shows the predicted literacy growth based off the actual score for each individual from deaf parents (1) and hearing parents (0). Bold lines represent the mean growth trajectories for the groups.
## Appendix A

### STUDENT APPLICATION FORM

**ALL SECTIONS MUST BE COMPLETED TO PROCESS APPLICATION**

<table>
<thead>
<tr>
<th>1. Student's Name</th>
<th>Last</th>
<th>First</th>
<th>Middle</th>
<th>Birthdate: month/day/year</th>
</tr>
</thead>
</table>

**PLEASE ATTACH A COPY OF CHILD'S BIRTH CERTIFICATE.**

<table>
<thead>
<tr>
<th>Is the child a twin?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

**Is the child a United States Citizen?**

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

**If not, Citizen of what country?**

<table>
<thead>
<tr>
<th>Nickname:</th>
</tr>
</thead>
</table>

**If child's name was ever changed, what was it before?**

<table>
<thead>
<tr>
<th>Number:</th>
</tr>
</thead>
</table>

**Does child have a Social Security number?**

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

**Number:**

2. Are natural parents separated? or divorced? If so, indicate who has custody:

| / |

**If a court order has been issued regarding custody of child, ATTACH certified copy of court order.**

3. Who has educational rights concerning the child?

4. Parent(s) in home other than natural parents: (Check all that apply)

- Stepfather
- Foster Father
- Adoptive Father
- Guardian
- Stepmother
- Foster Mother
- Adoptive Mother
- Other

**Name**

<table>
<thead>
<tr>
<th>First</th>
<th>Middle</th>
<th>Last</th>
<th>Phone</th>
</tr>
</thead>
</table>

**Address**

<table>
<thead>
<tr>
<th>Street</th>
<th>City</th>
<th>State</th>
<th>Zip</th>
<th>Occupation</th>
</tr>
</thead>
</table>

5. Person to contact in case of emergency, other than parents:

**Name**

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Street</th>
<th>City</th>
<th>State</th>
<th>Zip</th>
<th>Phone</th>
</tr>
</thead>
</table>

**( )

6. Brothers and Sisters:

**Name**

<table>
<thead>
<tr>
<th>Birthday</th>
<th>Living in home?</th>
<th>Deaf?</th>
</tr>
</thead>
</table>

7. If an agency is involved with the child, please list name(s):

**Agency worker:**

| Phone | |
|-------|-

**Address**

<table>
<thead>
<tr>
<th>Street</th>
<th>City</th>
<th>County</th>
<th>State</th>
<th>Zip</th>
</tr>
</thead>
</table>
10. Name the language most often used by adults at home: (American Sign Language (ASL), English, name other languages)

Father communicates with child by: (Check all that apply)
- Speech
- Fingerspelling
- ASL
- Gestures
- Writing

Mother communicates with child by: (Check all that apply)
- Speech
- Fingerspelling
- ASL
- Gestures
- Writing

What language does your son or daughter most frequently use at home?

Which language did your child learn when he or she first began to talk or communicate?

Do you understand spoken English?  Yes ☐ No ☐

If no, name persons in your home who can interpret:

Do you understand written English?  Yes ☐ No ☐

If no, name persons in your home who can interpret:

Do you understand American Sign Language?  Yes ☐ No ☐

If no, name persons in your home who can interpret:

Other information about your child you think the school should have:

---

### CHILD'S FAMILY BACKGROUND

<table>
<thead>
<tr>
<th>Name of Student</th>
<th>DOB</th>
<th>Grade &amp; Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your Name</td>
<td>Your Relationship to Student</td>
<td>Date</td>
</tr>
</tbody>
</table>

List household members, their relationships, ages, education levels and hearing status.

1. Name | Relationship
2. Age | Level of Education | Hearing or Deaf
3. Name | Relationship
4. Age | Level of Education | Hearing or Deaf
5. Name | Relationship
6. Age | Level of Education | Hearing or Deaf

---

### BIRTH MOTHER'S HISTORY

<table>
<thead>
<tr>
<th>Biological Mother's Name</th>
<th>Legal Guardian (Yes/No)</th>
<th>Living/Deceased?</th>
<th>Highest Academic Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Place of Employment</td>
<td>How long?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City, State, Zip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnic Background</td>
<td>Primary Language</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Work # Voice/TTY/Fax</td>
<td>Y/Marital Status</td>
<td></td>
</tr>
<tr>
<td>Any major medical problems?</td>
<td>Deaf or HH?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### BIRTH FATHER'S HISTORY

<table>
<thead>
<tr>
<th>Biological Father's Name</th>
<th>Legal Guardian (Yes/No)</th>
<th>Living/Deceased?</th>
<th>Highest Academic Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Place of Employment</td>
<td>How long?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City, State, Zip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnic Background</td>
<td>Primary Language</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Work # Voice/TTY/Fax</td>
<td>Y/Marital Status</td>
<td></td>
</tr>
<tr>
<td>Any major medical problems?</td>
<td>Deaf or HH?</td>
<td></td>
<td></td>
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</tbody>
</table>
# CHILD'S SCHOOL HISTORY

<table>
<thead>
<tr>
<th>PRESENT SCHOOL</th>
<th>( \text{Not in school Y} \square )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child's teacher's name</td>
<td></td>
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<tr>
<td>Name of School</td>
<td></td>
</tr>
<tr>
<td>Address</td>
<td></td>
</tr>
<tr>
<td>City, State, Zip</td>
<td></td>
</tr>
<tr>
<td>Phone</td>
<td>Fax</td>
</tr>
<tr>
<td>School District Contact Name</td>
<td>Phone</td>
</tr>
<tr>
<td>Name of School District</td>
<td>Phone</td>
</tr>
<tr>
<td>Was child enrolled in D/HH Program? Yes / No</td>
<td>How Long ____ ?</td>
</tr>
<tr>
<td>What other types of program has your child been placed in? (e.g., Communicatively Handicapped or Learning Disabled class)</td>
<td></td>
</tr>
<tr>
<td>What is your child's attitude toward school?</td>
<td></td>
</tr>
<tr>
<td>Any Behavior problems? (Please describe)</td>
<td></td>
</tr>
</tbody>
</table>

Did your child have a behavior plan in the classroom? Yes / No
Was this plan used consistently? Yes / No
Was the plan effective in helping your child improve his/her behavior? Yes / No
Was your child receiving designated services from a Behavior Specialist? Yes / No

## FORMER SCHOOLS:
Please list all previous schools attended (Use back of paper if necessary):

<table>
<thead>
<tr>
<th>School's Name</th>
<th>City and State</th>
<th>Dates Attended</th>
<th>Type of Class (e.g., D/HH)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td><strong>MEDICAL AND DEVELOPMENTAL HISTORY</strong></td>
<td></td>
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<tr>
<td>--------------------------------------</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>HISTORY OF HEARING LOSS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At what age did you first suspect child's hearing loss?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At what age was the child diagnosed?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What was the cause of the hearing loss?</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>What type of hearing loss does the child have? (Please Y)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensorineural (Nerve)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conductive (Bone)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What degree is the loss? (Please Y)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild (25-40dB)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate (40-65dB)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe (65-90dB)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profound (90dB+)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When did child first receive services for hearing loss?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At what age were hearing aids introduced?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How many hearing aids does he/she wear?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How many hours per day are the aids worn?</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Does child have Cochlear Implant? Yes / No</td>
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<td></td>
</tr>
<tr>
<td>Name:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family members who also have had hearing loss (Living or Deceased):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name:</td>
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<td></td>
</tr>
<tr>
<td>Relationship:</td>
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<td></td>
</tr>
<tr>
<td>Cause:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Describe how student uses speech:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does not use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At what age was sign language introduced?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What form of communication does your child use at home?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speaking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fingerspelling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sign Language</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gestures</td>
<td></td>
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<td></td>
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<tr>
<td>Writing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What form of communication do you use to communicate with your child?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speaking</td>
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<td>Fingerspelling</td>
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<tr>
<td>Sign Language</td>
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<tr>
<td>Gestures</td>
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<tr>
<td>Writing</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PREGNANCY &amp; BIRTH HISTORY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In what month did mother consult physician?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did she have regular examinations during her pregnancy? Yes / No</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>PREGNANCY HISTORY</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother's health during pregnancy:</td>
</tr>
<tr>
<td>Smoked: No / Yes How much?</td>
</tr>
<tr>
<td>Drank Alcohol: No / Yes How much?</td>
</tr>
<tr>
<td>Consumed Medications: No / Yes? Please indicate the names and prescribed dosages for medications:</td>
</tr>
<tr>
<td>Consumed Drugs during pregnancy: No / Yes? Please indicate the names, how much, and how often:</td>
</tr>
<tr>
<td>Did the mother experience any trauma or stress during the pregnancy? No / Yes</td>
</tr>
<tr>
<td>Please describe:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>LABOR AND DELIVERY</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of pregnancy</td>
</tr>
<tr>
<td>Birth weight lbs oz</td>
</tr>
<tr>
<td>Type of delivery: (please Y and describe where necessary)</td>
</tr>
<tr>
<td>Labor was: Spontaneous or Induced</td>
</tr>
<tr>
<td>How long did labor last?</td>
</tr>
<tr>
<td>Delivery was: vaginal with forceps with anesthesia C-section</td>
</tr>
<tr>
<td>If C-section, surgery was planned or Emergency</td>
</tr>
<tr>
<td>Baby was born head first OR Breech</td>
</tr>
<tr>
<td>Was there blood incompatibility? (e.g., Rh factor?) No / Yes</td>
</tr>
<tr>
<td>Were any abnormalities noted at birth? No / Yes</td>
</tr>
<tr>
<td>Please Describe:</td>
</tr>
<tr>
<td>Was the baby blue at birth? No / Yes How long?</td>
</tr>
<tr>
<td>Was the baby yellow at birth? No / Yes How long?</td>
</tr>
<tr>
<td>Did the baby have any trouble breathing? No / Yes What was done to initiate breathing:</td>
</tr>
<tr>
<td>Was oxygen administered? No / Yes</td>
</tr>
<tr>
<td>Were blood transfusions administered? No / Yes</td>
</tr>
<tr>
<td>Was the child in an incubator? No / Yes How long?</td>
</tr>
</tbody>
</table>
LITERACY IN DEAF CHILDREN

Did the child require Special Care? No ______ Yes ______
Please describe: ________________________________

How long?
Was there any evidence of paralysis? No ______ Yes ______
(Temporary or permanent?) _________________________
Any convulsions or seizures? No ______ Yes ______
What kind of treatment was administered?

Day of discharge from the hospital ______ mother ______ baby ______

BABY’S FIRST MONTH:

Incident: ________________

<table>
<thead>
<tr>
<th>Incident</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anoxia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfusion</td>
<td></td>
<td></td>
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<tr>
<td>Incubator</td>
<td></td>
<td></td>
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<tr>
<td>Jaundice</td>
<td></td>
<td></td>
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<tr>
<td>Poor Feeding</td>
<td></td>
<td></td>
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<tr>
<td>Rehospitalization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resuscitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seizures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Describe infant’s behavior (e.g., cried/slept/ate a lot):

Describe baby’s health during first month of life:

DEVELOPMENTAL HISTORY

Developmental Milestones
Rolled over at ________ months
Crawled at ________ months
Sat unsupported at ________ months
Walked unsupported at ________ months
Used two or three word sentences at ________ months
Spoke two/three word sentences at ________ months
Toilet trained (bladder) at ________ years
Toilet trained (bowel) at ________ years
Dressed self at ________ years
Bed-wetting after the age of 5? No ______ Yes ______
Tricycle riding at ________ years
Bicycle riding at ________ years

Emotional / Behavioral Symptoms (first 3 years of life)

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Babysitter difficulty</td>
<td>Frequent crying</td>
<td></td>
</tr>
<tr>
<td>Excessive rocking</td>
<td>Tantrums</td>
<td></td>
</tr>
<tr>
<td>Colic</td>
<td>Discipline problems</td>
<td></td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>Head banging</td>
<td></td>
</tr>
<tr>
<td>Feeding difficulty</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Sleep Disturbance</td>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

Which of these concerned you most?

Are any of these behaviors still occurring? No ______ Yes ______
Please describe:

MEDICAL HISTORY:

Date of child’s last physical examination:

Are immunizations current and complete?

Is your child allergic to any specific food(s) or medication(s)?

Is your child on a special diet or requiring special food preparations?

Has your child ever experienced any of the following? Hospitalization? No ______ Yes ______
Surgery? No ______ Yes ______
Major Accidents or Trauma? No ______ Yes ______ Please describe:

Has this child had any seizures? No ______ Yes ______
If yes, type:
I ast episode?
On average, how many seizures does your child have a month?
What was the date of the last EEG?
What medical and / or psychiatric diagnoses have been given to your child?

List any current medications your child is taking:

<table>
<thead>
<tr>
<th>Medication</th>
<th>Who Prescribed</th>
<th>Dosage</th>
<th>Date Started</th>
</tr>
</thead>
</table>

| | | | |
School intake form that parents’ fill out before their child is enrolled into the school. All of our background information on students were collected from this form.