Headturn preference of 10-month infants for familiar and unfamiliar signs

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Headturn Preference of 10-Month Infants for Familiar and Unfamiliar Signs

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A dissertation submitted to the Graduate Faculty of

JAMES MADISON UNIVERSITY

In

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Abstract

Most deaf babies born in the United States are born into hearing families and show a developmental lag in spoken language acquisition, reading, writing, and social development when compared to deaf babies of deaf parents or hearing babies of hearing parents, due to limited language access. A modified headturn paradigm has been devised to assess infant preference to various familiar and unfamiliar ASL stimuli, to determine parallels between auditory-spoken and visual-spatial languages. If visual perception of first signs parallels auditory perception of first words, we would expect infants exposed to ASL as their native language to show a preference for familiar signs over unfamiliar signs, similarly to infants’ preferences for familiar words found in their native language.

Eight participants, age 10 months + 21/-8 days (M = 10 months, 4 days; SD = 9.13), with various levels of exposure to ASL are reported in this study, with no significant findings. When the infants were separated based on level of ASL exposure, a trend was noted. Among the 3 infants with high ASL exposure, there was a significant difference between the looking times to familiar and unfamiliar stimuli using a paired samples t-test, t(2) = 9.449, p = .011. There was a near-significant difference between looking times using a non-parametric Wilcoxon signed-ranks test, T = -1.604; p = .109(ns), with the ranks for familiar totaling 6 and the ranks for unfamiliar totaling 0. Among the 5 infants of low ASL exposure, there was no significant difference between the looking times to familiar and unfamiliar stimuli, t(4) = -1.762, p = .153(ns); T = -1.483; p = .138(ns), with the ranks for familiar totaling 2 and the ranks for unfamiliar totaling 13.
There appears to be a trend toward a preference for familiar ASL signs among infants who are learning ASL as a native language (familiarity effect). There appears to be a trend toward a preference for unfamiliar ASL signs among infants who have a lesser degree of ASL exposure (novelty effect). Results assure a working method and suggest continued data collection and future avenues for research in lexical development of visual-spatial languages.
Chapter One: Introduction

Word recognition is an important aspect in infant development and to the development of language. Researchers in early infant lexical development have demonstrated through the years that perception and comprehension precede word production (Benedict, 1979; Hallé & de Boysson-Bardies, 1994; Oviatt, 1980; Thomas, Campos, Shucard, Ramsay, & Shucard, 1981; Werker & Byers-Heinlein, 2008). Early comprehension is revealed when infants begin noticing word forms that contain familiar sounds in their target language, at around 9 to 11 months of age (Hallé & De Boysson-Bardies, 1994; Werker & Byers-Heinlein, 2008). Before an infant reaches his or her first birthday, discrimination of speech sounds begins to align with the phonology of his native language, the language to which he is primarily exposed (Swingley, 2005). These early learning principles—first, that comprehension precedes and facilitates production; and second, that early comprehension is demonstrated in a preference for native language—are important to this investigation.

The period of development at which infants can meaningfully comprehend words in the target language but not yet produce it as such varies across investigators. Benedict’s (1979) studies, as well as more current researchers (Swingley, 2005; Werker & Byers-Heinlein, 2008), have shown that in hearing infants, language comprehension is demonstrated around 11 months of age when infants attend to familiar words in their native language longer than they attend to unfamiliar words or words of foreign languages. Thomas and colleagues (1981) reported that 13-month-old infants attended to familiar spoken words more frequently than to nonsense words that held no meaning. Between 9 and 13 months, then, lexical development progresses rapidly with an increase
in babbled consonants that are easy for infants to produce and also occur more frequently in the words to which babies are exposed. Around an infant’s first birthday, when words begin to emerge, the system of acquisition moves from babble and baby talk toward production of the first words in the native language, often consisting of the earliest babbled consonants.

While information is available from infant studies of different spoken languages and under various conditions, a review of literature reveals a lack of research exploring the development of a manual language system in infants who are deaf or part of a deaf family that uses sign language. Several parallel hypotheses support the present investigation of infants exposed to American Sign Language (ASL). First, ASL and other signed languages are like spoken English and other spoken languages in that both hearing and deaf infants acquire them unremarkably from parents who use them as their native language (Petitto, Katerelos, Levy, Guana, Tétreault, & Farraro, 2001). Second, comprehension of signs is like comprehension of words, with familiar or frequently used—and easily produced—signs learned prior to unfamiliar or infrequently used signs (Bonvillian, Orlansky, & Novack, 1983). Third, the phonetic complexity of familiar signs, like the phonetic complexity of familiar words, is developmentally important to comprehension and production of an infant’s first words or first signs.

Perception and production of spoken languages in infancy has a very large literature base. Those who espouse frame-content theory suggest that early vocal schemes come from reflexive opening and closing of the mouth, or oscillatory movement patterns of the mandible that appear at birth to enable suckling (McNeilage & Davis, 1993). Those who support constructionist theories developed by Chomsky (1972) think
that infant language is predisposed genetically and evolves from exposure to those who use it. Still others like Iverson and Thelen (1999) and Vihman, DePaolis, and Keren-Portnoy (2009) promote a dynamic systems perspective (consistent with the frame-content theory), in which perception and action combine with developmental variability to enhance learning, which leads to an infant’s development of vocal and manual gestures that eventually take on linguistic meaning. This view suggests that gesturing truly is a foundation for both spoken and signed languages.

Bonvillian, Orlansky, and Novack (1983), and more recently, Anderson (2006) reported that sign language acquisition in children parallels spoken language acquisition, with possibly one important exception—infants exposed to sign language demonstrate an accelerated pattern of early language development. Several explanations exist for this trend. Earlier control of gross muscle groups enables meaningful gestural communication before maturation of fine motor groups needed for production of spoken words (Iverson, 2010). Additionally, the articulators (hands) in signed languages are more easily visually accessible and able to be manipulated by a language model than the articulators (tongue and velum) in spoken languages (Bonvillian & Siedlecki, 1996; McIntire, 1977; Seal, 2010). It is much easier for an infant to observe and imitate the movement of hands that comprise meaningful manual utterances than mouth movements that comprise meaningful spoken utterances.

Other researchers, however, have argued that children across both vocal and manual modalities use pre-linguistic gestures in a communicative way (Seal, 2010; Volterra & Iverson, 1995; Volterra, Iverson, & Castrataro, 2006). These researchers suggest that fine motor development of the hands promotes fine motor development in
the mouth. Not only are the articulators in ASL (the hands) more visually accessible than the articulators of spoken languages (the tongue and velum), they are also more visible for parents who respond to and promote infant gestures as early communication (e.g. waving, pointing, and clapping). Therefore, perhaps the only advantage to acquiring ASL over spoken English is the visual-spatial aspect of the language.

Because sign languages are visual-spatial languages and because spoken languages are visual and auditory languages, it is appropriate to address infants’ anatomical development. The inner ear, the peripheral auditory system, is the only sense organ in the human body that is developed within the first half of the gestational period, and the cochlea is fully developed at birth (Northern & Downs, 1984). In contrast, the peripheral visual system develops more slowly over several months following birth (Sireteanu, Fronius, & Constantinescu, 1994). In contrast, higher central cortical processes of the auditory and vestibular systems develop more slowly than the visual cortex (Carmichael, 1964). Infant perception of spoken and manual languages appears to emerge in the second half of the first year of life when, in cases of normal development, both visual and auditory maturation are sufficient to communicate meaningful ideas.

Additionally, researchers have concluded that Broca’s language processing area of the brain is designated to language learning, regardless of the modality (MacSweeny, Mairéad, Campbell, Woll, Giampietro, David, et al., 2004). Additionally, hearing loss will cause the auditory cortex in the temporal lobe to be used for processing of non-auditory information, as well as multimodal integration in the parietal lobe where vision is typically processed. While research exists to support that perception precedes production in spoken-auditory languages, and the ages at which we can expect perception
and production to occur, we have little to support the same in the development of visual-spatial languages. (For a more exhaustive anatomical review of language processing in the brain see Malaia and Wilbur, 2010.)

Infant hearing loss has historically deprived children from acquiring the spoken languages of their hearing families and communities. This knowledge has led to widespread support for early detection of hearing loss in infants in order to promote early language intervention (Anderson, 2006). The incidence of hearing loss in infancy is reported at 1 to 2 per 1000 live births in America (Joint Committee on Infant Hearing, 1995; National Institutes of Health, 1993). In a 2009 review of nationwide results of hearing loss in infants, children, and adolescents, Mehra and colleagues reported that “of infants born in 2004, the incidence of permanent childhood hearing loss as reported by 47 states was 1.1 per 1000 screened (p. 462)” with a range of .22-3.61 per 1,000 screened. In this case, hearing loss was defined as having a pure tone average of less than 20dB in either or both ears. In children and adolescents “the average prevalence of children with an inability to hear or understand normal speech was 0.27 percent” (Mehra, Eavey, & Keamy, 2009, p. 462). This group also reported that “the average prevalence of any ‘hearing trouble’ was 1.9 percent (range, 1.3% to 4.9%)” (Mehra, Eavey, & Keamy, 2009, p. 462). In other reports, researchers have found severe to profound hearing loss in 1.5-2 per thousand live births with less severe hearing losses occurring in 25 per thousand live births (National Institutes of Health, 1993).

Regardless of the definition or classification of hearing loss, historically in the United States, diagnosis and intervention have occurred late in the critical language learning years. Late access to spoken language through improved audition has left
thousands of young children dependent on their visual-spatial access of sign languages for personal, social, and academic communication, and today we know very little about infant perception of signs for sign language learning.

Early in this century, most states had passed a legislative mandate for screening of all newborn babies prior to hospital discharge (Halpin, Smith, Widen & Chertoff, 2010). Today, all 50 states are in accordance with the universal newborn hearing screening legislation as well as the 1-3-6 standard practices implemented by the Joint Committee on Infant Hearing (JCIH). These standard practices have evolved from findings suggesting that children identified with hearing loss prior to 6 months of age present with higher receptive and expressive language skills than children who are identified later in life (Anderson, 2006; Yoshinaga-Itano, Sedey, Coulter, & Mehl, 1998). Implementation of this legislation enabled a much earlier intervention to both audition for spoken language access and signs as a catalyst to spoken language development and to ASL as a native first language.

The majority of deaf babies born in the United States are born to hearing parents and hearing families. Researchers in recent years have reported that of the estimated 500,000 infants with hearing loss living in the United States, 90-96% of them were born to hearing parents who have no prior exposure to or knowledge of ASL (Anderson & Reilly, 2002; Kushalnagar, Mathur, Moreland, Napoli, Osterling, Padden, et al., 2010; Moores, 2001). Typically, even among educated families, there is a limited or complete lack of understanding of deafness and ASL; therefore, these deaf babies of hearing families often lack exposure to meaningful language input until later in their development (Emmorey, 2002; Israeliite & Ewoldt, 1992; Johnson, Liddell, & Erting, 1989; Prinz &
Strong, 1998; Snoddon, 2008). Several researchers have shown that deaf babies who are
born into hearing families have a developmental lag in language acquisition, reading,
writing, and social development as opposed to deaf babies born to deaf parents (a much
smaller percentage) or hearing babies born to hearing parents (Snoddon, 2008). Other
researchers still suggest that regardless of the parental hearing status and the status of the
baby, there is an additional confounding factor of parental education that will predispose
a baby to higher or lower early vocal and gestural interactions after birth, and,
subsequently to higher or lower literacy gains (Seal, 2010).

A headturn paradigm has been devised to assess infant preference for various
speech stimuli across different spoken-auditory languages (Fernald, 1985). This
paradigm uses three stimuli presentations: one directly in front of, and one on either side
of the participant seated in the center of a booth. The test administrator is blinded to
which stimuli is being presented to the participant. During the randomized stimulus
presentations, the infant’s look to either the left or right stimulus presentation is recorded
by the experimenter, to obtain overall durations of looks toward the presented stimuli.
The experimenter can then determine the infant preference based on the length of looks
toward the familiar and unfamiliar speech stimuli (Fernald, 1985).

The current study aims to address whether infants who are exposed to ASL as
their native language will show similar trends as infants exposed to spoken-auditory
languages, by way of a headturn preference that has been modified to assess visual-
spatial language preference. If visual perception of first signs parallels auditory
perception of first words, we would expect infants exposed to ASL as their native
language to show a preference for familiar signs over unfamiliar signs, similarly to
hearing infants’ preferences for familiar words found in their native spoken language. The null hypothesis is that deaf and hearing infants who are exposed to ASL as their native language will NOT show an early perceptual preference for familiar, as opposed to unfamiliar, signs. We expect these infants to differ from hearing infants who are not exposed to ASL or to baby signing (as control group 1) and from hearing infants who are exposed to ASL (as control group 2) from their hearing parents. Critical to testing the hypothesis are knowledge of language acquisition and the processes of perception and production, across the auditory-spoken and visual-spatial modalities.
Early Language Perception

Hearing children learning spoken-auditory languages are able to comprehend spoken utterances several months before they are able to produce these same utterances (Falk, 1973; Werker & Byers-Heinlein, 2008). This earlier comprehension is due primarily to human biological predisposition to mature cognitively prior to maturation of those components used in articulation of spoken language. Additionally, production with the intent of meaning requires that there is prior understanding and therefore exposure to the words that comprise an infant’s lexicon (Huttenlocher, 1974). This lag in production following perception and understanding has consistently been shown, both empirically and through parental reports as existing until about 2 years of age when the child is expected to shift from a primarily perception-based language to primarily production-based language, and when the lexicon begins to align with intended meaning. Prior to this shift, infants are capable of being assessed based on a preference for their perception, regardless of their level of production (Fernald, 1985). It is not until later that the infant will begin to show aspects of production of a language based on the early exposure and perception of the same language—a shift that has been shown to occur from a “receptive stage” to a “productive stage” around 2 years of age, at which time both lexicons begin to align (Benedict, 1979; Goldin-Meadow, Seligman, & Gelman, 1976; Werker & Byers-Heinlein, 2008).

Investigators subsequent to Benedict’s (1979) study have reported that 13-month-old children have a receptive lexicon of about 45 words, but a productive lexicon of only about 11 words. However, as these are primarily parental reports, there is a tendency to
overestimate an infant’s capacity to meaningfully comprehend language (Clark & Hecht, 1983; Snyder, Bates, and Bretherton, 1981). Glenn and Cunningham (1982) used nursery rhymes read by the infant’s mother, and alternate nursery rhymes that were matched for tune and rhythm, but replaced with nonsense words to show an early (9-12 months old) preference for familiar language. Most recently, researchers interested in bilingualism from infancy have determined that prior to understanding the meaning behind a word, infants learning Welsh and English recognized frequently used words in both languages over infrequently used words, within the same expected age range (9-11 months old) as monolingual English infants. This is a precursor to the later development of recognition of the meaning behind the identified words (Vihman, Nakai, DePaolis, & Hallé, 2004; Werker & Byers-Heinlein, 2008)

In the early to mid 1990s, Jusczyk, Cutler, and Redanz (1993) and Jusczyk and Aslin (1995) demonstrated successful use of a modified headturn preference paradigm (Fernald, 1985) to indicate a perceptual preference in infants for different aspects of their native language. There was a significant difference in the looking times of 11-month-old infants to familiar French, English, and Dutch words (Hallé & de Boysson Bardies, 1994, 1996; Swingley, 2005; Vihman, Nakai, DePaolis, & Hallé, 2004), suggesting that prior to the expected production of the first word at around 1 year of age, infants show a preference for familiar words in that language over unfamiliar words. This is present in infants across several spoken-auditory languages including English, French, and Dutch, (Hallé & de Boysson Bardies, 1994, 1996; Swingley, 2005; Vihman, Nakai, DePaolis, & Hallé, 2004) but has not yet been investigated in visual-spatial languages.
Variations of the studies by Hallé & de Boysson Bardies (1994, 1996) and Vihman et al. (2004), in which the stimuli were manipulated based on their onset versus medial consonant of the target (CVCV) words, have variable significance in the findings. This equates to different manipulations in the place, handshape, and location in the visual-spatial domain and potentially could reveal similarities therein. However, the present study was not interested in manipulation of the signs used; rather the difference in infant preference for familiar signs and unfamiliar signs, a subsequent study might yield findings similar to the spoken language results. Researchers have revealed that infants show a preference for familiar words over unfamiliar words, when spoken without variation with respect to their onset and offset.

As American Sign Language (ASL) categorically meets all requirements to be considered a language, we would expect similar results to be obtained in a visual-spatial modality. However, there have been studies to suggest that children developing visual-spatial languages show an earlier onset of first word (sign) than their speaking counterparts (Anderson, 2006; Bonvillian, 1986). In this respect, we might expect a slightly earlier optimal age to determine this preference for familiar signs like the hearing babies in the studies recently mentioned. However, researchers who disagree with this developmental paradigm, discussed above, provide findings that suggest using the 9 to 11 month period is an appropriate age to assess language preference in infants learning ASL as their native language.

Studies conducted using the headturn preference paradigm confirm across several researchers and several languages, both monolingual and bilingual, that phonological processing is intact prior to language production. Additionally, they have confirmed that
hearing infants will show a preference for correctly pronounced familiar words in the native language over incorrectly pronounced or unfamiliar words. Furthermore, this is evidence of development of an early lexicon in the native language across several spoken languages. This is reason to suspect that a similar finding will develop in (deaf) infants whose native language is a visual-spatial language, primarily ASL. Hearing Infants who are born into a deaf family of ASL users are indeed growing up bilingual, learning both ASL and English (Petitto, Katerelos, Levy, Guana, Tétreault, & Ferraro, 2001), of which ASL will be their native language. Therefore, it is important to note the correlation between monolingual language development as well as bilingual language development, and that infants reach the same age-appropriate developmental milestones in one or two spoken languages (Werker & Byers-Heinlein, 2008).

**Early Language Production**

Historically, language development in humans has drawn much attention and debate as characteristic particular to humans alone (Cormican, 1975). Through the historical approaches to explain this phenomenon, psychologists like Chomsky (1972) and Lenneberg (1964) have struggled with nature versus nurture explanations. Neurologists have suggested that the ability to develop language is subsequent to biological maturation and physiological and neuromuscular mechanisms (Mussen et al., 1974). However, what is innately human about language acquisition is not particular to learning English over Japanese or any other spoken-auditory language, and furthermore, the production of speech does not effectively demonstrate knowledge of the language. Rather, Chomsky (1965) found that there are several particular domains of language acquisition. These include representation of input signals and their structural
information, a method to determine meaning, and a selection of adaptations to make for the native language structure, all of which are present regardless of language modality. Essentially, infants are equipped with an innate ability to learn language; it is then their surroundings and levels of exposure that determine which language will develop.

Subsequent studies have been designed in an attempt to explain the systematic development of language, as it is differentiated between various spoken languages. Perhaps the most widely agreed upon theory about language development is that no child has the capacity to develop language without exposure to it (Cormican, 1975). Additionally, because there are sensitive periods during which language exposure must occur for development and mastery of a language, children without a language model (or access to a language model in the case of deaf children) never acquire a language fully (Langacker, 1973). However, imitation of an adult model alone does not classify as learning a language. With a model, children are presented with a finite number of arbitrary linguistic symbols, which can then be used to form an infinite number of communicative ideas (Thomas, 1965). Thus, languages are governed by rules of phonology, grammar, syntax and semantics which enable the creation of an infinite number of spoken meaningful utterances. Essentially, children experience incidental learning of language, such that neither early modeling of well formed examples of spoken language, nor filling in missing elements of children’s speech will increase the knowledge of grammar in a child (Mussen et al., 1974).

The vast majority of this information, outlining early language acquisition as an innately human capacity occurring in a predictable manner across languages, fails to include or exclude the modality of language acquisition. Indeed, most of the literature...
addresses the acquisition of spoken-auditory languages. However, according to Petitto and Marentette (1991) in their study of 2 deaf infants of deaf parents and 2 hearing infants of hearing parents, early babbling is an “expression of an amodal, brain-based language capacity that is linked to an expressive capacity capable of producing speech and sign” (p. 1495). Similar to how hearing infants develop spoken language through stages of babbling and acquisition of the finite sounds to construct infinite words, deaf infants and hearing infants of deaf parents develop the finite motions to comprise the infinite elements of signed languages. Therefore, the speech mode of communication is not critical in the progression of infantile babbling and language acquisition (Petitto & Marentette, 1991).

Orlansky and Bonvillian’s (1985) longitudinal study of 13 children with one or both parents who are deaf discovered that the first recognizable sign was at an average of 8.6 months with a vocabulary of about 9.5 signs at age 12 months, and increasing to 48.2 signs by 18 months of age. Their data support earlier findings that infants learning manual languages reach expected linguistic milestones before their speaking counterparts, who speak their first words between 11 and 14 months (Orlansky & Bonvillian, 1985). Additional studies that recognized that signed and spoken languages are equally linguistically complex enough to classify them both as individual languages also suggest that there are parallels in errors that are produced when learning the language. In both spoken English and British Sign Language (BSL), the emerging phonological forms of a child learning the language, while they approximate the target, are often quite different from the standards which are accepted. Additionally, there are expected substitutions that use a less complex variation of the sign or spoken utterance
than what is accepted as an adult production (Kirk, 2008; Mann, Marshall, Mason, & Morgan, 2010). Both of these are seen in children developing language across the two modalities and are accepted in the developmental process of language acquisition.

Bates and colleagues in the late 1970s suggested that linguistic proficiency is obtained through the acquisition and use of both vocal (babble) and manual (gesture) play. Here there is a disconnect in the literature between Petitto and Marentette’s (1991) view that signed and spoken milestones are reached at a similar age regardless of modality, and earlier views that suggest that signing infants reach milestones 2 to 3 months prior to hearing and speaking counterparts (McIntire, 1977; Prinz & Prinz, 1979; Schlesinger & Meadow, 1972; Williams, 1976). These early researchers, while using small sample sizes to stake their claims, attributed the earlier acquisition of manual language to the earlier development of the visual and motor areas of the brain.

According to studies by deCrinis (1932) and later by Carmichael (1964) (as cited in Bonvillian & Orlansky, 1983), the cellular maturation of Broca’s language processing area in the brain is slower in the speech area than it is in the motor area. This developmental lag can be seen during these early months of infant development, such that the speech area at 14 months of age has not yet reached the level of development of the motor area at 9 months of age. Additionally, the visual cortex of the brain has been shown to mature prior to the auditory cortex (Bay, 1975). These findings suggest that infants exposed to visual-spatial languages rather than spoken-auditory languages would present with earlier models for language acquisition and growth, and have the opportunity to access the elements of language that are fundamental in the development of a lexicon.
Despite early findings that children receive little benefit from formal or structured attempts at increasing language learning, parents and researchers continue to show interest in how children are learning language and whether language learning in hearing infants can be accelerated with the addition of sign language exposure (Anderson, 2006; Seal, 2010). Recent attention to the use of sign language with infants and young children in anticipation that they will have increased linguistic development are based solely upon anecdotal claims attesting to the success of children who are exposed to baby sign across language, cognitive, social, and emotional domains (Volterra, Iverson, & Castrataro, 2006). This “sign language explosion” (Seal, 2010) has subsequently led to a substantial growth in the production and promotion of commercial materials for parents to use baby sign with their infants. This boom in perhaps non-existing benefits of signing with infants has brought about several issues across professionals who work with young children, political debate, and unrest within the Deaf community. But what these claims lack is empirical evidence showing a language advantage of those infants exposed to baby sign, as well as any proof that what these children are producing is indeed sign language or language at all.

Caution must be taken to define the difference between babies exposed to baby sign and babies of deaf parents who are exposed to ASL as a native language. First, a native language or first language is the language one is exposed to from birth and during the critical period of language development (Bloomfield, 1995). Therefore, ASL is the native language of American infants of deaf parents who sign. These infants are set apart from native English learners as well as those infants whose parents expose them to baby sign. In a recent article, Seal (2010) defined baby sign as the use of signs from ASL, or
another signed language, with additional “motherese” modifications. These modifications include adjustments in the signing space, size, and length of the signed utterance so as to emphasize the sign that is being taught. The differences in these languages and the amount of exposure that a child has as his native language will dictate the growth and lexicon of the particular language.

Infants who are native ASL users and children who are native English speakers (the two groups in this study) undergo the same processes in acquiring language, across two different modalities (Malaia, 2010). Researchers have demonstrated that the early acquisition of language in general, whether spoken or signed, provides the same advantages across all linguistic domains including phonology, syntax, semantics, and pragmatics (Malaia, 2010). Therefore, we would expect that there would be little discrepancy between spoken language development of hearing infants of hearing parents and sign language development of deaf or hearing infants born to deaf, signing parents.

We know from several researchers that infants develop both spoken and signed languages in a predictable and uniform way according to established milestones (Bonvillian, Orlansky, & Novak 1983; Malaia, 2010; Petitto & Marentette, 1991). Both motor development and speech and language development show parallels throughout early infancy up to the production of the first word. Bonvillian and colleagues (1983) also suggested that children learning spoken language will increase their lexicon to a certain point and then it will cease to expand during the production stage. With children learning sign language in infancy, however, the lexicon grows continually throughout development, even as production is incorporated into the comprehension stages. Additionally, they found that most of the spoken language progress that can be seen
during these developmental milestones will parallel a spurt in motor development. This brings up the question as to whether or not spoken language acquisition and manual language acquisition occur in the same or similar areas of the brain.

The human brain is capable of reorganizing after sensory deprivation through a process called neural plasticity in which the deprived areas begin to develop with respect to a separate sensory input, a theory that has been referred to as deprivation compensation (Bottari, Turatto, Bonfoli, Abbadessa, Selmi, Beltrame, & Pavani, 2008). In an experiment comparing vision tasks of deaf individuals and hearing individuals, it was determined that deaf individuals were better than hearing matches at detecting visual changes in their periphery. On the other hand, no changes were seen between the two groups when visual changes were presented toward the center of their visual fields.

These data suggest that perhaps the increased visual performance in the periphery of deaf individuals is due to the reorganization of the auditory cortex to provide more emphasis to sensory information it is actually receiving (visual rather than auditory). Through this research, it has been found that areas of our brain that were originally developed to perform certain sensory tasks (in this case hearing in the auditory cortex), are able to alter in ways that they are useful with respect to other sensory stimulation (visual). Based on the research behind this study, individuals who were thought to have had no stimulation of the auditory cortex due to profound sensorineural hearing loss or deafness, are actually adapting somewhat in that plastic reorganization might allow stimulation of, or nearby to, the deprived auditory area to be stimulated by visual input. These and other researchers looking at neuroimaging studies of deaf stroke patients and cochlear implant recipients support hypotheses that neural processing for sign language is
the same as neural processing for spoken languages—but they also leave us without information on how babies perceive sign language during the early acquisition stages (Campbell, MacSweeny, & Waters 2008; Petitto, Zatorre, Guana, Nikelski, Dostie, & Evans, 2000).

**Development Profile for Spoken English**

All typically developing infants progress through predictable and expected milestones when acquiring a spoken language. First, children will produce sounds that are unrelated to the target language. These consist mostly of standard cries to express needs until about the third month of life when typically developing children add vowel-dominated cooing sounds such as /i/, /e/, and /u/ with velar stop consonants like /k/ and /g/ (Falk, 1973). These early developed sounds occur across all spoken languages as the child has not yet classified the sounds that are contained within the native language. Additionally, deaf children produce these cooing sounds early on as well. Therefore, at this earliest stage of life, there is no differentiation between hearing infants exposed to spoken language and deaf infants who lack this auditory exposure.

Into the fifth and sixth months, infants’ babbling development shows trends indicative of a purely nature-dominated developmental progression. Production includes sounds found in languages across the spectrum, containing those in the native language as well as sounds that are never heard in the language (Stone & Church, 1973). At about 10 months of age a baby will begin to babble in such a way that is reflective of the intonation of the language to which he is exposed. At this time, English infant babble is discernibly different from Japanese infant babble, etc. From here, it is expected that the infant will develop his first true word in the target language anywhere between 8 and 18
months of age, determined as a sequence of sounds that holds the same meaning of the adult model of the target utterance. This trend of development continues as the infant first learns sounds that are very different in his production, /i/ and /u/ as they differ greatly from the initial /a/, and will progress to sounds that are more similar in their formation. Likewise the formation of consonant sounds from bilabial (/b/ and /p/) and velar (/k/ and /g/) stops to more medially produced alveolar (/t/ and /d/) stops and finally to fricatives and affricates (Falk, 1973). Thus, we have an anterior/posterior to medial development of these sounds which will eventually be used to produce the spoken language of the given infant.

Early development of sounds to form meaningful words is fundamental in lexical formation for meaningful comprehension and production of language. Through the process of building a lexicon, an infant must classify and store sounds for later recall for optimal language production (Hallé & de Boysson Bardies, 1994). It is largely and empirically agreed upon that perception of words precedes production of words with respect to learning a spoken-auditory language. In other words, receptive language will develop prior to expressive language, indicating that infants will understand their native language in some capacity prior to correctly producing it (Benedict, 1979; Goldin-Meadow, Seligman, & Gelman, 1976; Hallé & De Boysson Bardies, 1994; Huttenlocher, 1974).

The focus of the current study is on the preference for familiar aspects of the native language over unfamiliar aspects. Indeed, this entails the age group at the latter end of the previous discussion, around the time that the infant is beginning to develop a lexicon of his own. While researchers have struggled to come up with an agreeable
definition of language, there are largely acceptable constituents that must be present to form a language (Tserdanelis & Wong, 2004). The main constituents that characterize a language defined as such (as English is) include morphology, phonology, syntax, and semantics. According to Tserdanelis and Wong (2004), morphology entails how words are constructed from individual units that provide meaning. Phonology involves the elements (sounds, in a spoken language) within a language that can be manipulated and contrasted to encode information. Syntax pertains to sentence formation using smaller linguistic constituents, and how these sentences relate to each other to express ideas. Semantics brings meaning to language, depending upon the construction of the four prior characteristics. Manipulation of these individual characteristics of language enables a native speaker to create novel ideas to produce an infinite number of meaningful utterances. The focus of this investigation is on how infants exposed to ASL might demonstrate early perception of early signs, those that represent the phonology and semantics of a native language, and that potentially become the foundation for later morphology and syntax.

Recently, researchers have adopted the idea that development of spoken language is not without a concurrent manual development and gestural production (Iverson, 2010; Seal, 2010). In her review, Iverson (2010) mentions that not only are the first 18 months of life critical in the development of spoken language, but also a critical motor developmental period. Also, there are developmentally normalized assessment tools including the Communicative Development Inventory (CDI) (Anderson & Reilly, 2002) and the Communication and Symbolic Behavior Scale (CSBS) (Wetherby & Prizant, 2003), which provide a standardized measure regarding the co-development of spoken
language and communicative gestures. This theory, however, comes in opposition to the suspected (yet unproven) idea that when children begin to develop new motor skills, there is a halt in spoken language development. Therefore, information regarding motor, speech, and language development must be considered together in the assessment of child development as a whole. As infants progress through the expected developmental milestones of language acquisition, there are also changes in motor skill development (Iverson, 2010). However, is there a relationship between the development of gross motor skills and the fine motor skills of speech development? Iverson (2010) argues that developmental motor changes that occur in infancy potentially impact later language development by providing additional opportunities for linguistic exposure.

With few exceptions, the early gesture literature focuses on deictic (e.g., pointing) and emblematic (e.g., using a banana as a telephone) gestures that emerge at or around 9 to 10 months of age, before and during the acquisition of first words (Iverson & Fagan, 2004; Iverson & Thelen, 1999). Goodwyn and colleagues (2000) reported that between the time when infants are able to point and reach for their needs (around 10 months) and when they are able to meaningfully verbalize what it is they need (around 24 months) there is a time period of frustration due to the inability to communicate effectively. It is during this time that infants are driven to communicate meaningfully but may not yet have developed the fine motor skills to use speech effectively. Development of different motor movements and the co-development of reduplicated, variegated, and meaningful babble has also been explored (Iverson, 2010). Iverson stated that her review is applicable across different modalities of signed and spoken language and that there should be no major differences in the developmental course of either.
In a separate study, Seal, DePaolis, An, Baird, and Kulsar (2011) revealed expected gestural developments that occur during infant prelinguistic production of babble. In a review of videotaped sessions with 9- to 18-month old English babies (See Vihman, DePaolis, & Hallé, 2004) Seal and colleagues (2011) discovered that as these infants were developing different sounds in their babble, there were consistent gestural productions as well. Sixteen babies who participated in this study were divided into 2 groups of 8, those who had no exposure to British Sign Language (BSL), and those who had prior exposure. Gestural findings of paired exposed and non-exposed infants found that their ability to produce different gestures consistently showed a correlation between the development of certain sounds during babble and handshapes during babble production. In 97% of the 8 exposed and 98% of the 8 non-exposed infants, there was a noticeable gestural production occurring simultaneously with spontaneous babble production during play; however the exposed infants showed more frequent gestural productions (Seal et al., 2011). There was no statistical difference between the handshape that was produced.

**Development Profile for American Sign Language**

Deaf children’s language development parallels the development of spoken language in hearing children up until about 3 to 6 months of age (Falk, 1973). Additionally, both hearing and deaf children will typically begin to show gestural production before their first words. This has been suggestive of the beginnings of a framework for the development of language regardless of the modality, and can even be a predictor of spoken language onset (Bates, Benigni, Bretherton, Camaioni & Volterra, 1979; Bates, Camaioni & Volterra, 1975; Bruner, 1978). From the vantage point of
development of visual-spatial languages, there is also a parallel in phonemic language
development and spoken language acquisition during early stages (Petitto & Marentette,
1991). Therefore, the first language that is learned by an infant occurs in the same
manner, and around the same age, regardless of the modality. Also, whether hearing or
deaf and exposed to spoken language or a signed language, all infants progress through
periods of both an articulatory vocal babble and a gestural babble. It is in later stages,
when an infant is learning the elements that make his native language unique and
meaningful, that these begin to diverge.

American Sign Language (ASL) is the primary means of communicating among
most prelingually deaf individuals in the United States (Padden, 1980). It is a visual-
spatial language that is used in the United States and passed down through generations of
deaf individuals, and the only means by which profoundly deaf children are able to obtain
adequate access to linguistic structure and normal language development (Wilbur, 2008).
It is also the native language of hearing infants born into families where one or both of
the parents use ASL as their primary means of communication.

The linguistic structure of ASL is different and distinct from English and other
spoken languages, having its own grammatical structure, morphology, phonology, and
syntactical rules for production. Seminal work by Stokoe (1960) suggests that ASL holds
every aspect of a language that spoken English and other spoken languages follow. The
linguistic constituents of morphology, phonology, syntax, and semantics that are found in
spoken English carry over into ASL through different handshapes, facial expressions, and
body movements—along with a subset of syntactical rules that are very different from
those in spoken English—thus referred to as cheremes (Stokoe, 1960). Indeed it is a separate language (Petitto, 2001).

Because researchers have determined developmental similarities between infants who are developing spoken lexicons in different auditory languages (English, French, Dutch), we can establish a hypothesis that we would see somewhat similar findings when infants who are exposed to ASL as a primary means of communication are examined. In fact, children who have sign language exposure as a native language have been shown to have developmental milestone parallels to their speaking counterparts, including emergence of a first sign, early sign combinations, and mastery of the syntax of the target language (Chamberlain, Morford, & Mayberry, 2000; Morgan & Woll, 2002; Petitto et al., 2001; Schick, Marschark, & Spencer, 2005; Wilbur, 2008).

Infants who are born deaf do not have the same immediate access to spoken language that their hearing peers have. This is often a setback from the very moment of birth between hearing infants of hearing parents and deaf infants of hearing parents (Mehler, Jusczyk, Lambertz, Halsted, Bertoncini, & Amiel-Tison 1988; Wilbur, 2008) as these children already lack the en-utero access to spoken language of the mother. Alternately, hearing children born of deaf parents lack the initial spoken language exposure that infants of hearing families have, thus their native language is also ASL.

Earlier studies conducted in Russia suggested that introduction of a manual language will cause delays in spoken language acquisition (Vygotsky, 1978). However, more recent studies have concluded that a delay in accessing language is not a cause of a delay in child language production; rather parents who deprive their children of language based on this early belief will cause a delay in lexical growth (e.g., Kuntze 1998; Nelson
1998; Wilbur, 2008). Vygotsky eventually realized that not only is manual communication essential to language acquisition of deaf infants, but that they were also unable to access any spoken cultural or linguistic cues. Other early studies suggest that when children are acquiring ASL as a native language, they will typically produce their first sign several months prior to the speaking child’s first word (Holmes & Holmes, 1980; McIntire, 1977; Prinz & Prinz, 1979; Schlesinger & Meadow, 1972).

More current research shows that deaf children whose native language is ASL will reach developmental milestones similar to those of hearing, speaking children (Maxwell 1983, 1984; Newport and Meier 1985). Moreover, studies of deaf infants of deaf parents have reported higher academic standing among those children with signing parents (e.g., Chamberlain, Marford, & Mayberry 2000; Quigley & Frisina 1961; Vernon & Koh 1970). Additionally, early exposure of deaf infants to a manual language shows greater parallels to written English proficiency and literacy (e.g., Hoffmeister 2002; Padden & Ramsey 2000; Strong & Prinz 1997). From these studies, we can conclude that young deaf children who are exposed to sign language from signing parents will show age-appropriate milestone development similar to hearing children exposed to a spoken language. Additionally, we can conclude that ASL is indeed a language.

Children who are born to parents who are fluent users of ASL will acquire ASL as their native language through a process of incidental and natural ongoing exposure at home (Malaia, 2010). These deaf children of deaf adults are typically expected to achieve higher levels of academic success than their deaf peers who are not as exposed to ASL early on. However, these deaf individuals are more apt to have trouble acquiring skills in written English when compared to their hearing peers who have early English
exposure. This becomes a case of bilingualism in that the child who is primarily exposed to English early on (if the parents are educated), mostly through non-verbal cues, will consider ASL his native language once he is exposed to it in the schools. Additionally, hearing infants of deaf parents have been shown to have lower-than-normal Word Recognition Scores (WRS) when tested in the auditory domain only, based on their lack of spoken language access. There is a lack of evidence of infant perception of sign language and their attention to their native language in a manual modality.

An alternate group of individuals falls outside of either of the aforementioned groups—deaf infants born to hearing parents who do not expose them to sign language. Ninety percent of deaf infants are born to hearing parents and families, most of which do not know any sign language (Mitchell & Karchmer, 2004). Because the parents are not signing with these infants, and without auditory access to language, there is inevitably a delay in the acquisition of language prior to any sort of intervention. These children are delayed by the fact that they do not have exposure to any language system until they reach the school-age years, at which time, in America, they must begin to learn both ASL and English simultaneously. Even hearing parents who do begin signing to their deaf infants are unable to offer them adult-like use of the language that may be important to the infant’s natural and expected process of acquisition.

Like spoken language development, signed languages are comprised by organizing otherwise meaningless units into meaningful utterance (Stokoe, 1960). Signed languages (including ASL, BSL, etc.) have phonological parameters that can be equated to the linguistic parameters described in spoken English. These are the different phonological, morphological, and syntactical cues that are used in early language
development to produce the desired meaning (Baus, et al., 2008). Likewise, it has been proven that signed languages parallel this same developmental pattern using similar linguistic analyses to decompose a signed task into its simpler parts (Stokoe, 1960). Signed languages have their own morphology, phonology, and syntax. The main ways to differentiate between the different parameters fall under three categories – handshape, location, and movement or palm orientation. Like the individual parts of speech that comprise the spoken word, these three entities are meaningless when presented in isolation from each other, but when combined in different ways produce meaningful manual utterances. To parallel the intonation and prosody that is present and imperative in producing meaning in spoken languages, signed languages use non-manual features such as facial expression and body orientation to convey deeper linguistic ideas (Stokoe, 1960).

Of the three main phonological parameters that Stokoe (1960) described, handshape has been identified as the most difficult to master and to process (Mann et al., 2010). Following handshape, the movement aspect of signed languages is the second most difficult to master and to process. Lastly, the location aspect is the most easily learned component of signed languages and therefore the one that is least often produced incorrectly in children who are learning ASL as their native language. Of the substitutions that are made in early handshape misconfigurations, most of the errors are in using a simplified version of the intended sign. As previously discussed, this is common across children learning a spoken language as well, and thus the two entities can be linked when discussing the development of language across the two modalities.
Tools for Assessing Language Development

Researchers in the field of Communication Sciences and Disorders have long valued the importance of assessing language throughout development and across the life span. This is seen along the various screening and diagnostic tools that are available to assess spoken language development, to determine eligibility for special services and early intervention, and to track progress against normative data (Fenson, Dale, Reznick, Bates, & Pethick, 1994).

There are several experimental procedures that use either behavioral or observational reports to evaluate spoken language acquisition and understanding in infants and young children. Included is the use of a verbal command coinciding with a visual representation of the referent. One study by Thomas and colleagues in 1981 tested the comprehension of known referents versus unknown referents in 11- and 13-month-old children using a behavioral task. This study found that the 13-month-old children looked proportionally longer to the referent when a known word was spoken than when a nonsense word was spoken. In the 11-month group, however, the same result was not obtained for any of the known or unknown stimuli, leading to the belief of a developmental shift in identification occurring between 11 and 13 months of age.

Most investigators who test infants and their perception for language use a headturn paradigm to assess infants in these communication tasks (Hallé & de Boysson-Bardies, 1994; Juszczyk, Cutler, & Rendaz, 1993). This paradigm has been successful in assessing different aspects of spoken language including early lexical development (Hallé & de Boysson-Bardies, 1994), recognition of familiar words (Swingley, 2005), and the role of accentual patterns in spoken language (Vihman et al., 2004).
These behavioral tests of infants are primarily based on two elements, the infant preference for one stimulus over another, and the known versus unknown element of the stimuli that are used. Glenn and Cunningham (1982) tested infants who were 8 to 12 months of age to determine their preference for familiar nursery rhymes sung by the mother (familiar) versus the same tonal and temporal nursery rhymes substituted with non-word inversions. They determined that these infants could recognize familiar words in the selected nursery rhymes; however the non-word phonemic inversions resulted in non-English sound combinations. Therefore, it can only be determined that infants have a preference for sounds that are familiar in their language as opposed to sounds that are not generally found in their native language.

No such studies have been conducted using infants who are exposed to sign language. Several studies have looked into the importance of using sign language with infants in their overall development and spoken language acquisition (Bonvillian et al., 1983; 1996), but none have explored the early lexicon in babies who communicate using a visual-spatial modality. Furthermore, prior to this study and the development of the visual preference paradigm, there exists no data regarding the linguistic preferences of infants developing a visual-spatial language.

The current study aims to determine the parallel between spoken and manual language development in prelinguistic infants. As discussed, primary contrasts in the phonology and semantics of spoken languages are identified during infancy, before production begins to occur. These primary phonological contrasts also exist in ASL, and we expect that they would also be identifiable to infants who are exposed to ASL. The use of a visually adapted head turn paradigm should enable us to determine if infants
exposed to sign language show a preference for signs that have been deemed familiar more so than signs that are unfamiliar at this developmental stage. This study also hopes to determine if infants exposed to a manual mode of communication (ASL) as their native language develop at the same rate as infants from previous studies, who have been tested in the auditory domain, based on their preference for familiar sign stimuli.

Observational tests have also been developed to assess language acquisition in infants and young children. Unlike the behavioral tests involving the headturn paradigm, parental reports comprise early language acquisition in infants. The *MacArthur-Bates Communicative Development Inventory (CDI): Words and Gestures* was developed as a self-administered parental report of English language development in infants age 8 to 16 months and toddlers age 17 to 30 months by way of a checklist. While the assessment is a parental report, it holds high validity and reproducibility in its administration, making it a valuable component to the available behavioral assessments (Fenson et al., 1994). The first portion of the infant assessment consists of 396 vocabulary words organized semantically into 19 different check lists. Parents report whether or not the child has an understanding of these words or uses these words at a given age. The second portion of the infant assessment consists of reporting on the use of actions and gestures. This and other studies (Seal 2010; Seal et al., 2011) have shown a co-development of gestural and linguistic babble in hearing babies, both of which are predictable across expected developmental milestones. The normative data that were developed using the English CDI for infants represent 659 infants age 8 to 16 months across different ethnicities and parental education levels (Fenson et al., 1994).
Subsequent to the development of the CDI in English, it has been translated into several other spoken-auditory languages for early assessment over the last 20 years, including Spanish, Italian, and Japanese (Fenson et al., 1994). In 2002, the CDI was adapted for use with infants whose native language is ASL to learn more about the language acquisition process of this demographic (Anderson & Reilly, 2002). To make the relevant adaptations from a spoken language (English) to a visual-spatial language (ASL), Anderson and Reilly (2002) had several adjustments to make. First, words that were not appropriate for this modality were excluded from the inventory, including animal sounds. Signed entities that were unique to this modality and not included in the spoken English forms were added, including items sensitive to Deaf Culture. Second, for English words that were identified using the same sign in ASL were combined to one element, thus omitting some of the otherwise identical noun/verb sign combinations that appear in ASL (e.g. EAT/FOOD, SIT/CHAIR, etc.). Lastly, the grammatical portions of the CDI were developed to reflect correct grammatical formations in ASL as they differ from those in spoken English. With the changes, the ASL-CDI represents 537 signs organized semantically into 20 different check lists and all questions regarding early development of grammar were maintained between the two test forms. The normative data for the ASL-CDI were developed using 69 children aged 8 to 36 months (Anderson & Reilly, 2002).

Audiologically, other simple behavioral tests have been used to test word recognition and language understanding in older children. Clinically acceptable assessments include Word Recognition Scores (WRS), Word Intelligibility by Picture Identification (WIPI), Phonetically Balanced Test of Speech Discrimination for Children.
(PBK-50), as well as other closed set word and sentence identification tests (Brandy, 2002). However, each of these tests is presented via the auditory domain for audiology, but meant to assess language understanding and vocabulary growth. Similar assessments of language do not exist outside of the auditory domain. This presents a problem with accurately assessing language in children and individuals who are not exposed to a spoken language as their primary means of communication and learning, leading to poorer scores on these assessments than is a true representation of language development. Therefore the results on these assessments are indicative of knowledge of the presentation language (English), not the present level of language in the individual primarily exposed to visual-spatial language (ASL).

The longstanding method for assessing language preference in infants has been Fernald’s (1985) headturn preference paradigm. Researchers have used this method with auditory stimuli to assess infant perception and preference for familiar sounds in the target language(s). This auditory preference paradigm (APP), used by Swingley (2005), Vihman and colleagues (2004), Hallé and Boysson-Bardies (1994), and others, has resulted in data suggesting the emergence of spoken languages. There is no equivalent method available to assess the same language emergence in infants who are primarily exposed to signed languages. The present study has modified the headturn and preference paradigms to present the infant with video-recorded visual ASL stimuli rather than auditory stimuli. For purposes of this report, it has been termed the visual preference paradigm (VPP), and follows the standard presentation originally reported in the headturn preference literature (Fernald, 1985; Jusczyk et al., 1993).
Chapter Three: Methods

There are several questions to which this research hopes to find answers; all of which focus on the lexical development of infants who are exposed to sign language and their ability to recognize the elements that comprise their native language (ASL for infants of deaf parents). Previously mentioned studies have used the auditory headturn paradigm to determine infant preference for his or her native spoken language. The adapted visual preference paradigm that was used in this study was executed in the same way, however visual stimuli was the target rather than auditory stimuli.

Test Participants:

Eleven infants age 10 months + 21/-8 days (M = 10 months, 4.64 days; SD = 7.78) participated in this experiment. These infants were either deaf infants of deaf parents, hearing infants of deaf parents, or hearing infants of hearing parents, all of whom were exposed, with variable degrees, to American Sign Language (ASL) during these early months of their lives. All participants were recruited through word of mouth and postings at and surrounding both James Madison University in Harrisonburg, VA and Gallaudet University in Washington, DC. Parents of the participants were asked to sign a consent to participate and for the results to be used in this study. Additionally, the parents of the infant participants were asked to confirm that the children were full-term births, void of complications, and that the children were currently normally-developing with the exception of hearing loss. Table 1 reveals the individual characteristics of each infant that was used for this experiment.
Table 1: Characteristics of Infant Participants.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Infant Hearing Status</th>
<th>Caregiver Hearing Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASLVPP1</td>
<td>Deaf</td>
<td>Deaf</td>
</tr>
<tr>
<td>ASLVPP2</td>
<td>Hearing</td>
<td>Hearing</td>
</tr>
<tr>
<td>ASLVPP3</td>
<td>Hearing</td>
<td>Deaf</td>
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<tr>
<td>ASLVPP4</td>
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<tr>
<td>ASLVPP8</td>
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<td>Deaf</td>
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<td>ASLVPP9</td>
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<td>Hearing</td>
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<tr>
<td>ASLVPP10</td>
<td>Deaf</td>
<td>Deaf</td>
</tr>
<tr>
<td>ASLVPP11</td>
<td>Hearing</td>
<td>Deaf</td>
</tr>
</tbody>
</table>

As an additional assessment of early language development, the parents of the infant participants were asked to complete the *MacArthur-Bates Communicative Development Inventory (CDI)*. The CDI is available both in spoken English and in ASL, and is a measure of early vocabulary development. The English CDI is available in two formats, for infants (age 8 to 16 months) and toddlers (age 16 to 30 months) and is based on a recognition format.

The ASL-CDI was used to access more information about normal language development processes of children who are deaf. The target areas of the ASL-CDI are early lexical and grammatical development of deaf children of deaf parents. Because most deaf children are born to hearing parents, there is often a lack of early access to ASL and these children are therefore at risk for early language delay (Anderson & Reilly, 2002). Unlike the CDI for children exposed to spoken English, the ASL-CDI is available only for infants (age 8 to 16 months), and is used to measure the production of early lexical development of ASL.
Test Development:

This study was performed following a study conducted at James Madison University as an undergraduate honors thesis (Baird, 2010). The prior study assessed the preference for familiar and unfamiliar signed stimuli of 12 infants aged 10 months ± 7 days who were not exposed to ASL. The results of this study found that there was no significant difference in infant looking times to familiar versus unfamiliar signed stimuli. This finding is important to the present study because it proves that there is nothing inherently interesting or attractive about the chosen stimuli that would cause infants with no prior exposure to prefer any signed stimulus over another. The same methods were employed for the current study with infants who had previous ASL exposure.

A visual headturn preference paradigm (VPP) was used to assess the participants’ preference for familiar and unfamiliar signs. This paradigm is based on the original auditory headturn preference paradigm (APP) used by Fernald in 1985 and later by Jusczyk et al. in 1993 in his studies testing infants in their preference for spoken language. Hallé and de Boysson-Bardies (1994, 1996) adapted the APP to investigate the onset of word form identification in typically developing French infants, showing that 11-month-old infants recognize familiar words to which they are exposed in everyday activities, not words presented to the infant as part of the experimental paradigm. The same paradigm was used by Vihman et al. (2004) and Swingley (2005) in follow-up studies assessing what parts of words are particularly salient to British-English and Dutch infants respectively. For this study, because we were interested in visual stimuli rather than auditory stimuli, we adapted the APP for the visual modality. Essentially, because we are assessing the same language preference that has been assessed in infants learning
spoken language for several years, the only modifications made were with the presentation of the visual stimuli in place of the auditory stimuli.

To do this, two labs were created at two separate testing locations, one at James Madison University and one at Gallaudet University. Both labs were targeted to serve identical purposes of assessing the sign preference of infants, and therefore were standardized with respect to all relevant visual appearances. Each lab was designed as a three-sided booth similar to the booth used for an auditory preference paradigm. Our booth (6ft x 6ft x 8ft) was comprised of neutral, non-reflective walls to isolate sources of infant distraction. On the front wall, a monitor was mounted to display the stimuli used for directing the infants’ attention to the center prior to stimuli presentation at either side. Below this monitor was a video recorder to record the looks of each infant as a response to the visual stimuli at either side. On each of the walls of the booth to the right and left of the infant was an additional monitor to display the signed stimuli used for the visual preference paradigm test. These monitors were angled at 45 degrees toward the infant for ease of viewing. In the center of the 3-sided booth was a chair, situated 65 inches from the center monitor for the caregiver and infant participants to sit in while viewing the presentation stimuli. A second video recorder was positioned at the back of the chair facing the monitors to record when the stimuli being presented.

A Macintosh OS X computer was used to control the stimuli presentation from a location outside of the three-sided booth used for testing. An alternate monitor was used to visualize the recorded looks of each infant during the test procedure. The Habit X 1.0 software (Cohen, Atkinson & Chaput, 2004) was used to code the infant looking times to each stimulus presentation. The combination of the live-feed monitor from the video
located in the front of the booth and the Habit X 1.0 software enabled the experimenter to use predetermined key strokes to record the length and frequency of infant gaze to visual stimuli presented either to the front, left, or right of the participant.

The main function of the front monitor was to direct the infant’s attention to the center after each stimuli presentation was completed. Once the participant was oriented forward, the same blinking light was presented to either the left or right monitor (randomized for each trial), preceding the selected stimuli. A look toward either the left or the right side was coded when the appropriate key stroke was pushed for a duration of more than 0.1 seconds. When each test trial was complete, a blinking red light was automatically displayed as an attention-getting stimulus on the center monitor to orient the infant’s attention back to the central location.

A nationally certified female sign language interpreter with 34 years of interpreting experience served as the test model. She was filmed presenting each of the predetermined sign stimuli with a neutral facial expression, wearing solid, non-distracting clothing in front of a neutral white background. The mouth of the model was maintained in a neutral position in order not to impact language understanding of the infant participants (Key, Stone & Williams, 2009). These controls were used to emphasize infant focus on the hands as they presented each stimulus. The original recording of the model was manipulated using the iMovie program to minimize variation between trials and to avoid noticeable transitions between each recording.

**Stimuli:**

The stimuli that were originally created for the control study (Baird, 2010) were used for this study. Prior to testing, the experimenter created separate pseudo-
randomized lists of stimuli. These lists were used to determine the order of sign stimuli that were to be used as the “familiar” and “unfamiliar” test trials. Additionally, the orders of presentation for the selected stimuli as well as side (left or right) of presentation of each trial were randomized. Two additional pretest trials were created using different unfamiliar ASL signs (not the same signs used as “unfamiliar” test stimuli). These two trials were played to either side of each participant prior to displaying the test stimuli and were not calculated into the overall looking times. Additionally, each pseudo-randomized list of stimuli was counterbalanced according to the first four and last two of the 12 test trials.

The experiment consisted of two phases, a familiarization phase followed by a test phase. The familiarization phase used the pretest trial signs to condition the infant participant to look at either side monitor when stimuli was administered. Each of the two trials of the familiarization phase consisted of a random sequence of 6 unfamiliar ASL signs of comparable complexity to the test stimuli. Each trial was 25 seconds in length and presented at a predetermined, randomized location of either the left or right side of the participant. After the familiarization phase was completed, the test trials were administered and the looking times were recorded for later analysis.

The stimuli that were selected for this study consisted of 6 ASL signs that were determined to be familiar through studies of observed early development and 6 ASL signs that were determined to be unfamiliar through studies that characterized them as late developing signs (Siedlecki & Bonvillian, 1993), see Table 2.
Due to studies that found location of ASL signs to be acquired first by developing infants (Bonvillian & Siedlecki, 1996), this was the primary condition that was used to match the familiar and unfamiliar sign stimuli. Movement of the ASL signs has been found as the second characteristic to develop during early sign language acquisition (Bonvillian & Siedlecki, 1996); therefore this condition was also used to match the familiar and unfamiliar sign stimuli. Lastly, the handshape aspect of the ASL sign is the last to develop in infants exposed to sign language and so this condition was also accounted for when selecting the lists of familiar and unfamiliar signs (Bonvillian & Siedlecki, 1998). Tables 3 and 4 display the cheremic characteristics (Stokoe, 1960)—along with the notations that were used—that were varied along the signs selected for this study, and how each was balanced along the conditions of familiar and unfamiliar signs.

Table 2: Cheremic Characteristics of Sign Stimuli

<table>
<thead>
<tr>
<th>ASL Sign</th>
<th>Location</th>
<th>Movement</th>
<th>Handshape</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Familiar Stimuli</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHOE</td>
<td>Ø</td>
<td>&lt; - &gt;</td>
<td>S</td>
</tr>
<tr>
<td>MORE</td>
<td>Ø</td>
<td>&lt; - &gt;</td>
<td>O</td>
</tr>
<tr>
<td>MINE</td>
<td>[ ]</td>
<td>+</td>
<td>5</td>
</tr>
<tr>
<td>PLEASE</td>
<td>[ ]</td>
<td>O</td>
<td>5</td>
</tr>
<tr>
<td>MOMMY</td>
<td>U</td>
<td>+</td>
<td>5</td>
</tr>
<tr>
<td>DRINK</td>
<td>U</td>
<td>↑</td>
<td>C</td>
</tr>
<tr>
<td><strong>Unfamiliar Stimuli</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SORORITY</td>
<td>Ø</td>
<td>ω</td>
<td>S</td>
</tr>
<tr>
<td>SPELLING</td>
<td>Ø</td>
<td>~~~</td>
<td>5</td>
</tr>
<tr>
<td>BLOUSE</td>
<td>[ ]</td>
<td>↑</td>
<td>5</td>
</tr>
<tr>
<td>CONGRESS</td>
<td>[ ]</td>
<td>&lt; - &gt;</td>
<td>C</td>
</tr>
<tr>
<td>CAFETERIA</td>
<td>U</td>
<td>&lt; - &gt;</td>
<td>C</td>
</tr>
<tr>
<td>ODOR</td>
<td>U</td>
<td>↑</td>
<td>5</td>
</tr>
</tbody>
</table>
Table 3: Cheremic Characteristics of Sign Stimuli: Matched between Familiar and Unfamiliar Stimuli

<table>
<thead>
<tr>
<th>SORORITY</th>
<th>SHOE</th>
<th>MORE</th>
<th>MINE</th>
<th>PLEASE</th>
<th>MOMMY</th>
<th>DRINK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø, S</td>
<td>Ø</td>
<td>Ø</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>SPELLING</td>
<td>Ø</td>
<td>Ø</td>
<td>[ ],</td>
<td>5</td>
<td>[ ], 5</td>
<td>5</td>
</tr>
<tr>
<td>BLOUSE</td>
<td>&lt; - &gt;</td>
<td>&lt; - &gt;</td>
<td>[]</td>
<td>[]</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>CONGRESS</td>
<td>&lt; - &gt;</td>
<td>&lt; - &gt;</td>
<td>[ ]</td>
<td>[ ]</td>
<td>U</td>
<td>U, C</td>
</tr>
<tr>
<td>CAFETERIA</td>
<td>&lt; - &gt;</td>
<td>&lt; - &gt;</td>
<td>5</td>
<td>5</td>
<td>U, 5</td>
<td>U, †</td>
</tr>
<tr>
<td>ODOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Notation used to Describe Location and Movement of ASL Stimuli

<table>
<thead>
<tr>
<th>Location</th>
<th>Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø</td>
<td>Neutral Space</td>
</tr>
<tr>
<td>[ ]</td>
<td>Trunk</td>
</tr>
<tr>
<td>U</td>
<td>Chin</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test Administration:

Prior to testing, parents were asked a series of questions about their infant’s level of exposure to ASL. Included in these questions was whether or not the parents suspected that the infant would recognize the signs that were selected as familiar for this study. Additionally, the parents were asked to self-rank their fluency with ASL on a scale of 1-10 (1 signifying no signing at all, and 10 signifying complete ASL fluency). This information was used later to evaluate the results that were obtained from each infant as they fell into the 3 categories discussed earlier.

Each infant participant was tested while positioned on the lap of his or her caregiver in a chair placed in the center of the test booth facing the front monitor. The caregiver was asked to wear lab safety goggles that were modified to prevent visualization of the stimuli presented on either of the side monitors. This was to control for a caregiver influencing the look of the infant participant. Prior to beginning the experiment, a second video camera was placed behind the participants to record the
stimuli as it was presented to either side. This video was used later in the analysis of overall looking times of each participant. The lights were dimmed in the test booth and only a single lamp remained on with the test monitors. There were no auditory stimuli involved in this procedure, and to account for the hearing participants, all auditory distractions were eliminated so as to orient only toward the visual presentations.

A blinking light was first displayed on the center monitor to direct the attention of the participant to the front of the test booth. When the experimenter judged that the infant was looking toward the front of the booth, the experimenter coded the appropriate key stroke to indicate a central gaze. The center light was then extinguished and the infant was presented with the previously pseudo-randomized test trials consisting of six familiar lists of signs and six unfamiliar lists of signs in randomized presentation orders. Each of the test trials was preceded by the same blinking light, to orient the infant’s gaze toward the appropriate presentation monitor. The duration of the infant’s look at the blinking light was later subtracted from the overall looking times using the footage captured using the rear camera. The experimenter continued to code looking times using the appropriate key strokes for the duration of the test. A look was determined as such once the infant had oriented his or her gaze at least 30 degrees in the direction of the test stimuli. If the participant did not look toward the appropriate side monitor within a three-second period, the stimulus extinguished and the center monitor again presented the blinking red light to reorient the participant. The entire test proceeded for approximately 8-10 minutes depending on the activity of the participant and the time required to redirect a central gaze between looks.
**Test Evaluation:**

Following the testing procedure, the video recordings were analyzed and compared with the calculated looking times from the Habit X 1.0 program. Because Habit was not developed for use with a visual preference paradigm, calculations had to be used to determine the actual looking times of the participants. The use of the rear camera enabled the experimenter to determine when the stimuli were playing during the infant’s recorded looks, and when the infant was looking at the blinking (attention getting) light proceeding. Because we had the attention getting light play prior to each set of 6 stimuli, we needed to assure that the calculated look times were only for looks at the ASL stimuli. Therefore the Adobe Premiere Pro CS-4 program was used to time-lock the front video with the rear video recordings to evaluate the infant looks toward the stimuli only. This program enables the examiner to progress through the recordings frame-by-frame and subtract the variable duration of looks toward the attention getting stimulus from the overall look times. The frames were then converted into seconds to determine the actual length of each look toward the ASL stimulus. Mean looking times were obtained for each infant participant’s looks to the familiar and unfamiliar stimuli.
Chapter Four: Results

Eleven infant participants, age 10 months + 21/-8 days (M = 10 months, 4.64 days; SD = 7.78), with various levels of exposure to ASL were tested for this study. Data were collected from identical laboratories located at James Madison University and Gallaudet University. One of the infants was unable to complete the testing procedure and so the data is not considered in the analysis of the results. Two other infants’ data were unable to be analyzed due to equipment malfunction. Of the 8 infants (M = 10 months, 4 days; SD = 9.13) whose data are reported here, 5 have both hearing parents, 2 have one or both deaf parents, and 1 has a deaf caregiver who interacts with the child daily. Along with the data collected from the headturn paradigm, the parents of each infant were asked to complete the CDI in ASL and an additional questionnaire as a standard for comparison and identification of level of sign exposure across the infants tested.

The mean looking times of individual participants are reported in Table 5 and Figures 1 and 2. Important to the analysis of these data is the level of ASL exposure that each infant has had. The infants of one or more deaf parents, as well as the infant with the deaf caregiver are expected to be learning ASL as a primary or native language, having 50% or more of their communicative interactions in ASL only. The infants of hearing parents have less exposure to ASL as a primary language and are primarily English language learners with supplements (to various degrees) using baby sign or ASL.
Table 5: Mean Looking Times (in seconds) of 8 Infants to Familiar and Unfamiliar ASL Signs.

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Caregiver Hearing Status</th>
<th>Unfamiliar</th>
<th>Familiar</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASLVPP1</td>
<td>Deaf</td>
<td>9.88</td>
<td>12</td>
</tr>
<tr>
<td>ASLVPP2</td>
<td>Hearing</td>
<td>11.27</td>
<td>10.08</td>
</tr>
<tr>
<td>ASLVPP3</td>
<td>Deaf</td>
<td>11.53</td>
<td>13.11</td>
</tr>
<tr>
<td>ASLVPP5</td>
<td>Hearing</td>
<td>14.90</td>
<td>10.51</td>
</tr>
<tr>
<td>ASLVPP6</td>
<td>Hearing</td>
<td>7.95</td>
<td>9.65</td>
</tr>
<tr>
<td>ASLVPP7</td>
<td>Hearing</td>
<td>15.69</td>
<td>12.85</td>
</tr>
<tr>
<td>ASLVPP9</td>
<td>Deaf</td>
<td>9.24</td>
<td>10.79</td>
</tr>
<tr>
<td>ASLVPP11</td>
<td>Hearing</td>
<td>9.83</td>
<td>7.58</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td></td>
<td><strong>11.29</strong></td>
<td><strong>10.82</strong></td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td></td>
<td><strong>2.72</strong></td>
<td><strong>1.82</strong></td>
</tr>
</tbody>
</table>

Figure 1: Individual Looking Times (in seconds) of 8 Infants to Familiar and Unfamiliar ASL Signs.
Figure 2: Individual Looking Times (in seconds) of 8 Infants to Familiar and Unfamiliar ASL Signs

The mean overall looking time to familiar signs was 10.82 seconds (SD = 1.82) and the mean overall looking time for unfamiliar signs was 11.29 (SD = 2.72) as shown in Figure 3. A two-tailed paired samples t-test reveals no significant preference for familiar or unfamiliar signs across the 8 participants, \( t(7) = -.512; p = .619(\text{ns}) \). Due to the small number of participants involved in this study, a Wilcoxon signed-ranks test was also performed to determine the difference between looking times of the 2 stimuli. This nonparametric test showed that there was no significant preference and no trend in the preference for familiar or unfamiliar signs across the 8 participants, \( T = .560; p = .575(\text{ns}) \), with the ranks for familiar totaling 14 and ranks for unfamiliar totaling 22.
However, when the participants were separated based on their level of exposure to ASL, there becomes a more identifiable trend. The mean overall looking time of 3 infants with high ASL exposure was 11.97 seconds (SD = 0.78) to familiar signs and 10.22 seconds (SD = 1.17) to unfamiliar signs. A two-tailed paired samples t-test reveals that there is a significant difference in the looking times of infants with high ASL exposure toward the familiar stimuli, $t(2) = 9.449; p = .011$. Since there were only 3 infants compared in the group having high ASL exposure, a Wilcoxon signed-ranks test was also performed to determine the difference between looking times of the 2 stimuli. This nonparametric test showed that there was no significant preference for familiar or unfamiliar signs across the 3 participants, but that there was a definite trend toward familiar stimuli, $T = -1.604; p = .109$ (ns), with the ranks for familiar totaling 6 and the ranks for unfamiliar totaling 0.

There also is a trend developing, yet still not statistically significant, among the infants with low ASL exposure, for a preference toward the unfamiliar stimuli. The mean
overall looking time of 5 infants with low ASL exposure was 10.13 seconds (SD = 1.89) to familiar signs and 11.93 seconds (SD = 3.03) to unfamiliar signs (Figure 4). A two-tailed paired samples t-test reveals no significant preference for familiar versus unfamiliar across the 5 infants with low ASL exposure, t(4) = -1.762; p = .153 (ns). A Wilcoxon signed-ranks test showed that there was no significant preference for familiar or unfamiliar signs across the 5 participants, but a slight trend toward the unfamiliar stimuli, T = -1.483; p = .138 (ns), with the ranks for familiar totaling 2 and the ranks for unfamiliar totaling 13.

**Figure 4:** Mean Looking Times (in seconds) of Infants with High (n=3) and Low (n=5) Exposure to ASL.

![Figure 4](image)

Further separation based upon the hearing status of the caregivers reveals more consistency between the two groups, based on the level of ASL exposure. Figure 5 reveals that the 3 infants with high ASL exposure looked significantly longer to (preferred) the familiar ASL stimuli than the matched infants with low ASL exposure.
**Figure 5**: Mean Looking Times (in seconds) of Infants with High ASL Exposure (n=3) for Familiar and Unfamiliar Stimuli

Figure 6 reveals, with more variability, the preferences among the 5 infants receiving less exposure to ASL. Four of these infants showed a preference for the unfamiliar ASL stimuli rather than the familiar stimuli. One of these infants showed the same trend as the infants with high exposure to ASL. These findings are not statistically significant.

**Figure 6**: Mean Looking Times (in seconds) of Infants with Low ASL Exposure (n=5) for Familiar and Unfamiliar Stimuli
To account for the variability in levels of ASL exposure across each of these infants, the parents were administered the *Communicative Development Inventory (CDI)* *in ASL*. Based on the parental reports, we were more able to separate the infants out based on their level of exposure to ASL. However, the CDI results are not available for the infants who were tested earlier in this experiment, making this method of standardization less desirable. The CDI information gathered from parents of infants who participated in this study are shown in Table 6. These numbers represent the number of ASL signs that parents reported their infant to have exposure to enough to be able to accurately recognize, while not producing, the ASL sign.

**Table 6: Level of Exposure Based on Raw Parental Reporting using the CDI for ASL.**

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Caregiver Hearing Status</th>
<th>Number of Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASLVPP1</td>
<td>Deaf</td>
<td>NA</td>
</tr>
<tr>
<td>ASLVPP2</td>
<td>Hearing</td>
<td>NA</td>
</tr>
<tr>
<td>ASLVPP3</td>
<td>Deaf</td>
<td>NA</td>
</tr>
<tr>
<td>ASLVPP5</td>
<td>Hearing</td>
<td>33</td>
</tr>
<tr>
<td>ASLVPP6</td>
<td>Hearing</td>
<td>9</td>
</tr>
<tr>
<td>ASLVPP7</td>
<td>Hearing</td>
<td>3</td>
</tr>
<tr>
<td>ASLVPP9</td>
<td>Deaf</td>
<td>20</td>
</tr>
<tr>
<td>ASLVPP11</td>
<td>Hearing</td>
<td>4</td>
</tr>
</tbody>
</table>

In addition to the CDI reporting, parents were also asked which of the familiar signs that were used in this experiment their infant would recognize as such. Table 7 shows the parental reports of how many of the 6 familiar signs parents report that their child might recognize. These parental reports reveal that the level of exposure to ASL that the infant has will affect the preference that is observed using the visual preference headturn paradigm. Infants who are learning ASL as a native language show preferences similar to infants of previous studies who show the same preference in their native spoken-auditory language. The same is not true for the infants who have less ASL
exposure from their hearing parents in the form of baby sign, with spoken English primarily used for communication.

Table 7: Parental Report of Infant’s Sign Lexicon (of 6 familiar signs used)

<table>
<thead>
<tr>
<th></th>
<th>Low ASL Exposure</th>
<th>High ASL Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASLVPP2</td>
<td>5</td>
<td>ASLVPP1</td>
</tr>
<tr>
<td>ASLVPP5</td>
<td>3</td>
<td>ASLVPP3</td>
</tr>
<tr>
<td>ASLVPP6</td>
<td>4</td>
<td>ASLVPP9</td>
</tr>
<tr>
<td>ASLVPP7</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>ASLVPP11</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>4.2</strong></td>
<td><strong>Average</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>2</strong></td>
</tr>
</tbody>
</table>

A two-tailed paired samples t-test revealed no significant difference between the overall looking times to familiar and unfamiliar stimuli across all 8 infants, \( t(7) = -0.521, p = 0.619 \) (ns). A Wilcoxon signed-ranks test also showed that there was no significant preference for familiar or unfamiliar signs across the 7 participants, \( T = 0.560; p = 0.575 \) (ns), with the ranks for familiar totaling 14 and ranks for unfamiliar totaling 22.

When the infants were separated based on their expected level of ASL exposure, there was more of a trend emerging. Because of the small number of participants in each grouping, these findings did not reach statistical significance. Among the 3 infants with high ASL exposure, there was a significant difference between the looking times to familiar and unfamiliar stimuli using a two-tailed paired samples t-test, \( t(2) = 9.449, p = 0.011 \); but did not reach statistical significance using the non-parametric Wilcoxon signed-ranks test, \( T = -1.604; p = 0.109 \) (ns), with the ranks for familiar totaling 6 and the ranks for unfamiliar totaling 0. Among the 5 infants of low ASL exposure, there was no significant difference between the looking times to familiar and unfamiliar stimuli, \( t(4) = -1.762, p = 0.153 \) (ns); \( T = -1.483; p = 0.138 \) (ns), with the ranks for familiar totaling 2 and the ranks for unfamiliar totaling 13.
The hypotheses, that infants exposed to ASL as their native language would show a preference for familiar signs and little interest in unfamiliar signs, similarly to infants’ preferences for familiar words found in their native language, was represented more strongly, while not significant, among infants exposed to a higher level of ASL signs. The separation of the infants who have ASL exposure as a primary language and those who are learning ASL with various levels of exposure while also acquiring spoken English as their native language became fundamental in the analysis of these results as they pertain to the hypotheses. Additionally, when compared to the control group of infants not exposed to ASL (Baird, 2010), these results are beginning to suggest some trends that were not represented in the control group.
Chapter Five: Discussion

The objective of this study was to determine preference for familiar versus unfamiliar ASL signs in 10-month infants with various levels of exposure to ASL. Infants classified as having a high level of exposure to ASL were those receiving at least 50% of their waking communicative interactions in ASL only. Of the 3 infants in this grouping, 2 had one or more deaf parents, and the other had a deaf primary daytime caregiver. Infants classified as having a low level of exposure to ASL were those receiving communicative interaction using simultaneous communication in spoken English and ASL, ASL only, or baby sign for less than 50% of their waking hours.

The first element was to assure that the design of the study was able to assess what was intended from both groups of test participants, those exposed to ASL as a primary language, and those learning ASL along with spoken English. To do this, information gathered during a previous, yet identical, study (Baird, 2010) of 8 infants of the same age who had no exposure to ASL found that there was no preference for the familiar (M = 11.11 seconds; SD = 2.74) or the unfamiliar (M = 11.34 seconds; SD = 3.02) sign stimuli, t(7) = .237, p = .820(ns).

A headturn preference paradigm (Fernald, 1985; Jusczyk, et al., 1993, 1995) was adapted into the visual domain using 6 familiar and 6 unfamiliar ASL signs which were video recorded and presented to an infant seated in the center of a 3-sided booth. The controlled environment and trained experimenters, who were blinded to the stimuli while it was being presented, assured that valid and consistent results were obtained from each infant. Using the Habit X 1.0 software (Cohen, Atkinson & Chaput, 2004), looking times
were calculated and averaged across each infant with respect to familiar or unfamiliar stimuli presentation.

Across the groups if participants that were tested, were hearing infants of both hearing parents, hearing infants of one or more deaf parents, and deaf infants of one or more deaf parents. There were no deaf infants of both hearing parents who participated in this study. However, the important variable among the cohorts is not the participant hearing status, rather the hearing status of the parents and caregivers, those who will provide the primary linguistic exposure and modeling over the course of the first 10 months of life. Therefore, separating the cohort into groups based on the hearing status of the parents was an appropriate assessment to deem a preference for the ASL sign stimuli that were used. Because the hearing infants of hearing parents would be primarily exposed to spoken English both incidentally and during parent-child interactions, we did not see a strong preference for either familiar or unfamiliar ASL signs. However, the infants of deaf parents, regardless of whether or not they were hearing themselves, did not have access to spoken English unless there was a speaking model (grandparent, sibling, etc.). Therefore, these infants would be primarily exposed to ASL, learning it as a native language. In this case, we would saw a preference for familiar ASL stimuli, just like researcher using various spoken-auditory language found that native speakers of those languages will show a preference for familiar sounds and words in that language.

The infant participants consisted of 5 hearing infants of hearing parents, having a low level of exposure to ASL and 3 hearing or deaf infants of deaf parents or caregivers, having a high level of exposure to ASL. The infants with low levels of exposure were all learning spoken English as a first language, while the infants with high levels of exposure
were learning American Sign Language as a first language. Here we see a difference in the results obtained from the two groups as the infants with less exposure tended to show a trend toward a novelty effect—showing a preference for the unfamiliar sign over the familiar signs. Conversely, the infants with more exposure tended to show a trend toward a familiarity effect—showing a preference for the familiar signs over the unfamiliar signs. While neither of the 2 groups of participants showed a statistically significant difference in the looking times to familiar or unfamiliar stimuli, there are several possible explanations for the trends that were evident in this study but not found in Baird’s (2010) study.

First, the infants of hearing parents (all hearing themselves) are primarily exposed to spoken English, and secondarily exposed to ASL, thus bilingual to some degree. All of these hearing parents rated themselves at or below 60% competent in using ASL, many of which were at or below 30% competent. Therefore, the level of exposure to ASL as a language is much less in the infants with hearing parents than the level of exposure in the infants with deaf parents and caregivers, who use ASL as a language in 100% of their daily communication. Rather the infants that were grouped in the less exposed category were receiving baby signs coupled with spoken English words, many of which fell into the familiar signs list used for this experiment.

In infant development, a familiarity effect will become a novelty effect with extended exposure to redundant stimuli. In the case of the families who use baby sign, or drilling of ASL signs that are frequently used, a novelty effect is revealed when presented with the sign stimuli that were used in this experiment. Because the infants had higher-than-normal exposure to the signs that were deemed familiar only, with no exposure to
the signs that were deemed unfamiliar, the preference for the new signs was greater. The infants of deaf adults, on the other hand (some hearing and some deaf), are primarily exposed to a wider vocabulary range of ASL signs and more complex linguistic entities, including both familiar and unfamiliar signs, with overexposure to neither group. These hearing infants only have exposure to spoken English from other hearing and speaking family members, again bilingual to some degree. Therefore, their interest remained in the familiar signs, ones that they perhaps were able to recognize and understand from their broad exposure to ASL.

Second, the variability in the cohort of infants that participated in this study contributes to the different effects that are noted between each group. While a qualitative assessment of the parental level of education was not a part of this study, it could have potential in accounting for the variability between the infants in different groups. Of the infants of deaf parents, there was a much higher variability in level of academic achievement of the parents than there was among the infants of hearing parents. Additionally, the level of overall communicative and non-communicative interaction between parents and infants, which was not qualitatively assessed, could account for variability in the performance within the groups of participants. However, there is no way to qualify the individual participant’s genetic gift and/or predisposition to language development.

Lastly, due to the small number of participants in each of the groupings presented here, it is difficult to note whether or not a preference for either set of stimuli is noted overall. While the group of infants with a higher level of ASL exposure showed significance using a paired-samples t-test, the small number of participants in this group
does not make this a reliable statistic. However, because we were able to identify trends using non-parametric statistics, this group of participants shows potential to show a significant difference in looking times toward familiar rather than unfamiliar ASL stimuli given a greater number of participants.

The data that were gathered during this study reveal that the participant population that is ideal for this study is 10-month infants of educated deaf users of ASL. Large numbers of these infants, however, were not readily able to be tested over the course of this study. The inclusion of infants exposed to various degrees of ASL provides insight into bilingual and cross-modal language development, as well as what levels of linguistic exposure are ideal in determining a preference for familiar or unfamiliar stimuli in the manual mode. The high variability within the group of infants with low exposure to ASL causes an inability to infer a preference for familiar versus unfamiliar ASL signs. Additionally, because many of these infants were not exposed to ASL as a language, rather to baby sign drills of familiar signs without the grammatical and expressive constituents of ASL as a language, the familiar signs were perhaps over learned, causing the trend of preference to move toward more novel stimuli.

The data presented herein demonstrates that the laboratory set-up and method is successful in identifying a preference if it exists in the population to be tested. While access to the population is limited and restricted by a narrow age range, the creation of a laboratory in a more ideal location (Gallaudet University in Washington, DC) enables further assessment of participants with a high level of exposure to ASL.

Earlier researchers have shown that there is a preference for different familiar aspects of spoken languages over unfamiliar aspects or foreign languages (Hallé & de
Boysson Bardies, 1994, 1996; Swingley, 2005; Vihman, Nakai, DePaolis, & Hallé, 2004). The present study has revealed trends suggesting that the same preference might occur in ASL and other visual-spatial languages, given an equivalent level of exposure to the language. All of the infants tested in these early studies were native language learners of the language being assessed. The hearing infants exposed to ASL are innately learners of two languages, thus there may be a bilingual effect on the emergence of a linguistic preference at 10 months.

This task and procedure has promise in determining perception of visual-spatial languages at the neural level as the same has already been established with hearing children and spoken-auditory languages. The headturn paradigm that was used in this experiment has been the long-standing method by which to assess linguistic preference and lexical development in infants in the auditory domain. The creation of a visual preference paradigm using the same method presented some variability in assessment. The primary difference between the method used here and Fernald’s (1985) method was the mode of presentation. To present video stimuli to the participant, we had to assure that they were responding to the video stimuli only. Therefore we needed not only a quiet testing environment, as needed in the auditory domain, but we also needed a method for gaining attention prior to the presentation of stimuli. In the auditory domain, lights are used to gain the visual attention of the participant to orient them to an auditory stimulus. By way of having a visual means of getting attention as well as a visual presentation of stimuli added some variability in these testing procedures.

The use of a blinking LED light presented on the monitor in front of the participant directed attention forward between stimulus presentations. This same
blinking light, however, also preceded each stimulus presentation on either of the side test monitors. Because Habit X 1.0 does not enable manipulation of the visual stimuli, the blinking light was not able to be extinguished when the participant oriented toward the stimuli. Therefore, the use of a second video camera enabled calculations during the analysis of the videos to adjust the looking times of the infants to the stimuli only, not toward the blinking light. A future creation of a program that can account for this adjustment while testing can decrease analysis time and increase accuracy of calculation of infant looks.

As it pertains to researchers interested in the language development of infants exposed to visual-spatial languages, this study has promising results that, given the proper exposure level, an infant learning ASL should show similar headturn preferences as infants assessed using the same procedure in their native spoken-auditory language. One caveat to note is that infants learning a visual-spatial language like ASL may not show similar trends at the same age as infants learning an auditory-spoken language. Our findings of infants who are 10 months old suggest that a trend toward preference for familiar signed stimuli is at least emerging, but that confounding factors including parental level ASL proficiency, level of education and communicative interaction, and exposure to a spoken language might also affect the results.

In addition to accounting for education and other demographics, the administration of the CDI or a similar assessment tool can provide insight into differences between deaf and hearing parents and their ratings. This assessment tool, and others like it, requires that parents are able to identify when and how their infant understands a communication task. Variation in parental reporting can be minimized
across groups with the same standard procedures used for each, as well as the possibility that a relationship of ASL exposure and familiar and unfamiliar looks exists. Additionally, the use of a standardized assessment of linguistic understanding has potential to reveal if an infant with a larger receptive vocabulary size (as these methods do not assess expressive vocabulary) would correlate with a longer average looking time to familiar or unfamiliar stimuli, or any similar trends.

The CDI was incorporated late into the current study to add strength via an additional measure to quantify the levels of ASL exposure across all of the test participants. Because the CDI was not used at the onset, we were unable to analyze partial parental reports on CDI development. A lack of the CDI information for some of the subjects in this study could also account for variability within the data collected.

The additional information parents reported on their infants’ expected sign familiarity suggest that the level of exposure does influence the preference for familiarity versus novelty, but in contrast to what might be expected. As shown previously in Table 7, the infants who had a low exposure to ASL had a high exposure to selected baby signs; they were ranked by their parents as understanding an average of 4.2 of the 6 familiar signs. Conversely, the infants with high exposure to ASL were ranked by their parents as understanding an average of 2 of the 6 familiar signs. These findings correspond to the variability in headturn preferences that were identified between the two groups. Additionally, these findings support that the infants in the less exposed group actually have an overexposure of familiar signs and little or no exposure to the unfamiliar signs, leading to a preference for novelty. On the other hand, the infants who are learning ASL
as a native language, with full exposure to every aspect of the language, are less likely to recognize the familiar signs as such, therefore preferring the familiar sign stimuli.

There are several avenues for future research projects that would contribute to studies in infant language development, primarily in the manual mode. First, continued collection of data from infants at age 10 months who are exposed to high levels of ASL will add to the power of the test. Second, a look into testing infants at various chronological ages, both younger than, and older than 10 months, would help to determine if manual language acquisition parallels spoken language acquisition. Third, collecting additional data of deaf infants of deaf parents, as well as deaf infants of hearing parents, will determine if a trend exists suggesting an earlier acquisition of ASL, causing the preference to move away from familiar toward unfamiliar. Conversely, to determine if deaf infants of deaf parents maintain the same expected lexical development as hearing infants of deaf parents and other participants with high levels of ASL exposure. Fourth, creating additional test stimuli with various adaptations to the signs to account for which cheremic aspects of sign language (Stokoe, 1960) can and cannot be changed while maintaining the same preference for familiarity or novelty in these infants.

The promising results obtained through the present study assure that this is a working method, with stimuli that will assess preference for familiar or unfamiliar ASL signs if a preference exists. With the addition of qualitative assessment tools for both the parents and participants, and access to infants of deaf parents, learning ASL as a native language, will reveal that spoken-auditory languages and visual-manual languages are equivalent in infants at 10 months of age. This study has potential for variations to be made to assess the different developmental aspects of visual-spatial language acquisition,
and to identify differences that might exist between hearing children learning spoken languages, deaf children learning manual languages, and bilingual/bimodal children learning languages in two separate modalities.
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