ASL Word Order Development in Bimodal Bilingual Children:
Early syntax of hearing and cochlear-implanted Deaf children from signing families

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A dissertation

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ABSTRACT

This study examines the word orders produced by heritage learners of American Sign Language (ASL) from video-recorded naturalistic sessions. These bimodal bilingual children are born to deaf signing parents but have auditory access to English. Commonly, these children are only exposed to ASL in the home and the dominant language, English, both in school and in the community. This dissertation tracks the production of canonical (SV and VO) and noncanonical (VS and OV) word orders of the subjects from ages 1;8 to 3;6 and compares them to deaf children (without cochlear implants) from deaf signing families.

Word order development is assessed by a first-repeated use measure of acquisition, examining the production of each of the four word orders under analysis, as well as the proportion of canonical and noncanonical word orders produced by session over time. Results reveal that when ASL-only and code-blended utterances are both taken into consideration, the bimodal bilingual children develop canonical word order at 23 months, similarly to the deaf comparison group. This suggests that the bimodal bilinguals set their spec-head and head-complement parameters very early.

However, the children diverge from the deaf controls in terms of their overall use and acquisition of noncanonical word orders, as confirmed by a mixed effects two-way linear regression showing an interaction between hearing status and noncanonical word order production. The deaf children produce significantly more OV utterances (β = -6.81; s.e. = 1.35; t = 5.03) and VS utterances (β = 5.32; s.e. = 1.35; t = 3.93) than the bimodal bilinguals. For OV word order, none of the bimodal bilinguals (n = 4) reached first-repeated use criterion by 42 months. For VS word order, the hearing bimodal bilinguals (n = 2) reached criterion more than

one year after the deaf children, while the cochlear-implanted deaf children (n = 2) never reached criterion. It is unclear if the bimodal bilinguals will eventually, later in life, produce more noncanonical utterances licensed by reordering morphology, or if this will remain a weaker component of their ASL grammar. Some aspects of grammar develop more slowly for bilingual children. However, this dissertation investigated the possibility of protracted development of noncanonical order by extending the period of observation by10 months. It was observed that production of noncanonical word orders still did not significantly increase over time. Thus, the data analyzed here are better characterized as illustrating divergent rather than protracted development for this domain. The results of this dissertation offer some of the first quantitative evidence to support the notion that bimodal bilinguals are heritage learners of ASL by identifying reordering morphology and resulting noncanonical word order as a specific aspect of their grammars that diverges from the deaf comparison group.

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CHAPTER 1 STATEMENT OF THE PROBLEM

1.1 Introduction

Most of the world's population is bilingual. From every city to every village you are likely to meet a person who knows more than one language. For a period of time here in the United States bilingualism was frowned upon, believed to cause confusion and most certainly an unwelcome distraction from proficiency in the language of power and prestige, English. Today much has changed and the benefits, and even advantages, of bilingualism are motivating parents to encourage their children to learn more than one language. However, researchers are far from fully understanding the process by which children acquire two languages simultaneously from birth.

Early research suggested that children effortlessly acquire both languages without delay or aberration. These studies were important to help counter the prevailing notion that bilingualism was harmful but, at the same time, minimized the differences between monolingual and bilingual learners. Today, the trend in bilingual research is to be more transparent about the differences between monolinguals and bilinguals regardless of how nuanced these differences may be. It is evident that the bilingual learner has less exposure to either language compared to monolingual comparisons. Thus, input for certain features may fall below the necessary threshold for optimal acquisition. In addition to input factors, various sociolinguistic factors help shape the bilingual's end-state grammar. This makes the study of bilingual language acquisition both challenging and compelling. Which features of a language are most vulnerable to reduced input? What are the factors that influence bilingual language development? Which factor, or set of factors, is/are most responsible for the outcomes we observe in the bilingual data?

This dissertation alone cannot answer all of these questions, however, it will offer insight regarding vulnerable features of the home or minority language and briefly examine possible explanatory factors. This study investigates the word orders produced by a unique population of bilinguals: bimodal bilinguals, or children that have auditory access to spoken English but use American Sign Language (ASL) with their deaf parents in the home. This study contributes to the growing body of research dedicated to understanding how bimodal bilingualism compares to unimodal bilingualism. The fundamental question guiding this study is whether bimodal bilingual children acquire the basic word order and the various derived word orders permissible in ASL. This dissertation will look at the development of ASL word order by bimodal bilingual children and compare their use, proportion of different word order types over time, along with a measure of acquisition, to a deaf comparison group.

Word order is one of the earliest aspects of the grammar that is acquired. Some languages have very consistent word order, such as English, which strictly adheres to canonical subject-verb-object order. Children who are exposed to English reliably use that word order from their earliest multi-word sentences (Brown 1970, Bloom 1973). On the other hand, many languages allow for various word orders, and the child must learn which ones are permissible in which contexts, and what type of grammatical features accompany or trigger the different permutations. Previous research has proposed that robust and consistent morphology facilitates acquisition of word order variation (Slobin 1982). Chen Pichler (2001) confirmed this is also the case for deaf native-signing children acquiring ASL. At a very young age, 20-30 months, deaf children consistently produce all the word orders investigated. Thus, word order appears to be controlled early for children who are either learning a fixed word order language (like English) or a variable

word order language in which morphology reliably accompanies noncanonical orders (like Turkish and ASL).

For bilingual children the task becomes more complex, particularly when the child is exposed to a fixed word order language and a variable word order language. In this situation, the children must distinguish between word order patterns that are common to both of their languages and those that are specific to only one language. Chapter 2 will include a review of several studies that have investigated bilingual variable word order. In general, the outcomes in these cases are much less consistent than for monolingual children and are potentially influenced by various language- internal and -external factors. One aim of this dissertation is to add to this growing body of research on bilingual word order acquisition and examine ways in which bimodal bilingual variable word order acquisition may or may not be as vulnerable to factors identified in the literature on unimodal bilinguals.

1.2 Defining Bimodal Bilingual and Code-Blending

This study investigates the word orders produced by four bilingual children natively acquiring American Sign Language and English. These bilinguals are unusual in that they are acquiring two languages in distinct modalities. Traditionally this population has been variously referred to as *Children of Deaf Adults* (Coda), *Kids of Deaf Adults* (Koda) or *Hearing Children of Deaf Parents* (HCDP). These are usually typically developing hearing children that have one or more deaf parents that use sign language in the home. However, the aforementioned terms have various identity implications that are outside the scope of this dissertation, so the term *bimodal bilingual* will be used here instead. Also, for this dissertation, the term bimodal bilingual will include deaf children with cochlear implants that have deaf signing parents (deaf of deaf with cochlear implants: DDCI). While the term bimodal bilingual has been used more

broadly in the literature to also include non-native L2 signers, the definition embraced here only includes bilinguals with native exposure to both languages.

An unusual consequence of bimodal bilingualism is the ability to produce both languages simultaneously. Unlike unimodal bilinguals, bimodal bilinguals do not frequently produce intersentential switches between their two languages. Instead, they favor *code-blending* (Emmorey et al. 2008), which is defined in this dissertation as the phonological output of both spoken language and signed language simultaneously. This can manifest in several ways, ranging from just one word/sign in an utterance being code-blended to the entire (or nearly the entire) utterance being code-blended. Code-blending is considered a natural phenomenon arising from the fact the bilingual's languages are transmitted via different channels and therefore the child does not need to actively suppress one language when producing another. Code-blending is different than SimCom in that the latter does not arise naturally and often prioritizes the phonation of English over the production of ASL, although this is not always the case. Chen Pichler et al. (to appear) offer a similar definition:

> We consider code blending to be distinct from simultaneous communication or SimCom in that the former occurs spontaneously in mixed Deaf-hearing households or among bimodal bilinguals, is generally accessible to all parties, and is used in low-stake, informal contexts, while the latter is essentially sign-supported English, and is noted for being largely inaccessible to Deaf addressees, particularly in high-stake contexts such as classroom lectures, meetings, etc. (Johnson et al. 1989, Tevenal & Villanueva 2009).

Importantly, the main distinction is that code-blending is a natural consequence of bilingualism occurring in different modalities, while SimCom is an educational technique that attempts to represent English features while providing sign support (for a review see Bishop 2010).

1.3 Overview of Dissertation

This study compares the spontaneous word orders produced by bimodal bilingual children with results presented in Chen Pichler (2001) of natively signing deaf children. Chapter 2 reviews the relevant literature regarding variable word order, ASL word order specifically, and early word order development by bilinguals. Chapter 3 details the various methodologies employed throughout this study. This includes both how the data were collected, transcribed and coded as well as the motivation for the specific analyses and statistical tests used.

Chapter 4 presents the results of the study in three parts: the proportion of each word order produced by each child, the developmental trajectory of each word order over time, and a measure of acquisition by *first-repeated use* (FRU). Throughout this entire chapter these results are compared with the data presented on natively signing deaf children from Chen Pichler (2001). The proportions of each word order taken directly from Chen Pichler (2001) while the developmental trajectory, first-repeated use and statistical analyses are all derived from the appendices and raw data made available by the author. This is in part to confirm Chen Pichler's interpretation, but also to create a more comprehensive picture of deaf children's word order acquisition path to adequately serve as the control benchmark for this study. The bimodal bilingual data are initially compared with the deaf control data using just the sign language utterances produced and for the same time period, to ensure a fair comparison. As the chapter unfolds, however, it becomes apparent that this stringent criterion should be loosened to include code-blended utterances and the time period extended to 10 months beyond that studied by Chen Pichler (2001).

In Chapter 5 several language -internal and -external factors are evaluated as potential factors influencing the observed bimodal bilingual word order patterns, including the influence

of code-blending, the role of parental input, and interlocutor effects. This dissertation concludes summarizing the results and with a brief discussion of the limitations of this study.

CHAPTER 2 REVIEW OF THE LITERATURE

2.1 Introduction

This dissertation relies heavily on the theories put forth by generative linguistics scholars over the past several decades to investigate how bimodal bilingual children acquire word order. Specifically, this study assumes a Principles and Parameters (Chomsky 1981) account of word orders patterns occurring in ASL. The Minimalist Program (Chomsky 1995) is also invoked to discuss the various language-mixing phenomena produced by bilinguals. Before delving into these two key frameworks it is important to clarify some assumptions made by generative linguists; many of these assumptions that were first formalized by Chomsky (1957).

The first assumption is that the human capacity for natural language is innate. This means that humans are uniquely endowed with specialized machinery for acquiring language. The second assumption is that children actively deduce grammatical rules from their input and that these rules dictate (generate) the children's production. Therefore, language is not a system of learned habits and behaviors but instead a computational system of rules and constraints. These rules run autonomously in the mind, very much like a computer program following a set of procedures, generating grammatical sentences.

If there were no innate computation system guiding language acquisition, we would expect children to make a whole host of mistakes when they first begin to form short sentences. It is true that the average 3-year-old produces ungrammatical sentences for one reason or another, however, when researchers study a single grammatical rule 3-year-olds obey the rule a majority of the time (Stromswold 1990; Marcus 1993). While it's true children sometimes err in their hypotheses about how their grammar works, they actually entertain very few of the many incorrect hypotheses that are logically possible (Snyder 2007). In addition, without a set of rules

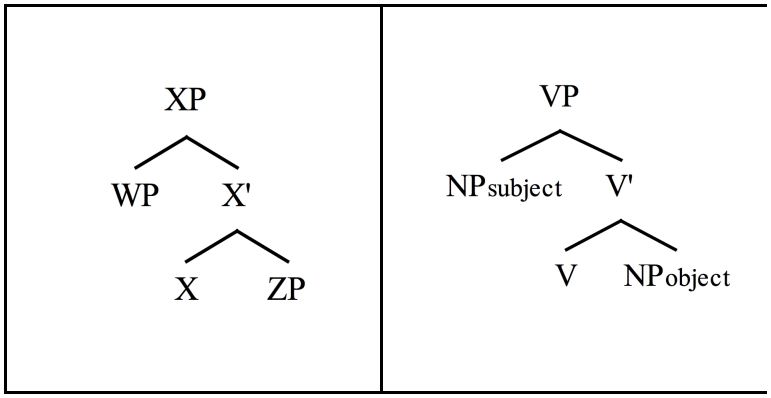
and constraints, we would also expect children to only utter structures that they received in the input, however, this is not the case either. Children often produce structures that can be traced back to a non-target-like grammatical rule rather than something heard in their environment. For example, children often overregularize past tense and produce words like 'runned' or 'eated'. Furthermore, if children deduce the grammatical rules of their input language, as generative linguistics proposes, they do so without explicit instruction or correction from adults (lack of negative evidence) and without the input necessarily providing enough evidence for the child to infer crucial aspects of all language structures. The latter claim is known as the *poverty of the stimulus* argument, and hinges on the notion that children's language input only informs them about which structures are grammatical, but does not inform them about ambiguous or ungrammatical structures. The fact that children are eventually able to deduce the correct grammatical rules of their language despite such insufficiencies in their input is taken as evidence that children are guided by innate linguistic knowledge (Universal Grammar) that significantly constrains the hypotheses children will entertain as they acquire their target language (see Thomas (2002) for a useful history and discussion of generative views on the poverty of the stimulus argument).

2.2 Parameter Setting & Basic Word Order

The Principles & Parameters framework (Chomsky 1981; Chomsky & Lasnik 1993) describes principles as abstract grammatical rules that serve as structural linguistic universals. Parameters, often conceptualized as switches, are options that can account for the various types of linguistic structure found across all the world's languages. The two parameters most relevant to this word order study are the specifier-head parameter and the head-complement parameter. The specifier-head parameter determines the relative order of some phrasal projection WP with

respect to the head of another projection XP; for example, the tree structure in (a) shows WP preceding the X head. By substituting the category of nouns (N) for the variable W, and verbs (V) for the variable X, we derive S-V word order, because NP specifiers occur to the left of verbs. The head-complement parameter determines the relative order of a head X and a phrasal projection ZP that serves as its complement. In the tree structure in Figure 2.1, ZP follows the head X. Substitution of V for the variable X and N for the variable Z, we derive VO word order, in which the verb head is followed by its NP complement. Children set the value of these parameters on the basis of primary linguistic data (i.e., the linguistic input the child receives during first-language acquisition) (Chomsky 1965:24) and once they do so, they acquire the canonical (basic) word order for their language[1].

Figure 2.1: Parameter setting schema



Basic word order refers to the order that is generated as a result of parameter setting. These basic word orders are the most pragmatically unmarked and the most syntactically simple. However, basic word order (or canonical) is only one option, as most languages also permit

[1] Basic word order includes the resulting word order after obligatory movement is applied. Namely, the VP-internal subject hypothesis posits that the subject of the sentence is originally part of the verb phrase in order to explicate the semantic

variations on the basic order as a result of syntactic or pragmatic operations, to be discussed in the next section. Since this theoretical framework is equally relevant to sign languages, as it is spoken languages, the following examples will be drawn from sign languages.

(1) SOV Language
Lingua dei Segni Italiana (LIS)

MARIA HOUSE BUY
S O V
'Mary buys a house.'

(Donati & Branchini 2013:101)

(2) SVO Language
American Sign Language (ASL)

MARY BUY HOUSE
S V O
'Mary buys a house.'

In Lingua dei Segni Italiana (LIS), an SOV language, the complement NP precedes the head V, whereas in American Sign Language (ASL), an SVO language, the head V precedes the complement NP. In the example of LIS, the object HOUSE precedes the verb BUY. In the ASL example, the object HOUSE comes after the verb BUY.

2.3 Nonbasic Word Order

Following the Principles & Parameters theory there are various movement operations that can take place result in a word order other than the basic word order. There were some early accounts claiming that sign languages did not have a basic word order and instead they were thought to have a free word order (Tervoort 1968; Friedman 1976)). However, these claims have been since refuted by numerous sign language linguists (e.g., Chinchor et al. 1976; Fischer 1975; Kegl 1977; 1985; Liddell 1977; 1980; Padden 1983; 1998; Neidle et al 2000). There is clear

evidence that sign languages are hierarchically organized; one type of evidence is the distribution of nonmanual marking over phrasal domains.

In addition to SVO basic word order in ASL, which is frequently used with reversible sentences and with plain verbs, there are several grammatically acceptable noncanonical word orders. The two noncanonical word orders permissible in ASL that are relevant to this study are OV and VS order. For object-verb ordering, several proposals posit that when the verb is morphologically marked it moves to the right-branching functional projection leaving the object in pre-verbal position (Fischer and Janis 1990; Matsuoka 1997; Chen Pichler 2001; Braze 2004). These morphological features can be an aspectually marked verb, use of space with a spatial verb, or a classifier handling/instrument verb type. For VS word order, ASL allows pronouns to appear post-verbally in sentence-final position (Coulter 1979). Padden (1983) notes sentences such as (6) where the pronoun is coindexed with the subject of the sentence. While all VS examples might not serve the same purpose, it appears that a vast majority of them "serve a pragmatic purpose, occurring in contrastive contexts, and are clearly emphatic" (Chen Pichler 2001: 18).

(3) ASL Aspectual marking

CAT SEARCH++
O V[aspect]
'I'm looking for the cat.'

(Chen Pichler 2001: 117)

(4) ASL Classifier use

BALL BOY HIT-with-bat
O S V[inst]
'The boy hit the ball (with the bat).'

(Liddell 1980: 91)

(5) ASL spatial verb

MONEY PUT-on-table
O V[sp]
'Just put the money on the table.'

(Chen Pichler 2001: 34)

(6) Subject pronoun copy (VS)

ME NERVOUS ME
'I'm nervous (I am).'

(Humphries & Padden 1992: 76)

2.4. Word Order in the Visual-Gestural Channel

Early linguistic analysis of sign languages mainly focused on patterns and phenomena that were universal. The quest to identify amodal linguistic universals played a pivotal role in not only the acceptance of sign languages as bone fide natural languages and also functioned as a sort of litmus test for claims about universality made by spoken language researchers to confirm that language universals hold true regardless of modality. In recent years more and more scholars are considering the importance of modality and exploring the notion that the visual-gestural nature of the language may play a role in influencing the structure of sign language. Therefore, it is important to note that modality pressures such as the unambiguity of pronouns established as points in space may influence the arrangement of the subject, verb and object at the sentential level (i.e., the ability to drop an object if the verb is displaced to the point in space associated with that object).

Relevant to this notion are analyses that have been conducted on natural sign languages as well as investigation of gesture. The most recent and influential work regarding word order in sign languages was conducted by Napoli and Sutton-Spence (2014). They developed several generalizations based on a survey of 42 articles on sign language and word order. The first is that

SOV word order is grammatical in all sign languages (under specific conditions). The second is that if an argument affects the phonological shape of the verb, it must precede the verb. This is true for a whole host of verbs in sign language such as classifier predicates (including handling and instrument verbs), agreeing verbs, aspect verbs, and spatial verbs. These verbs all show variable phonological shape compared to plain verbs. Thus, if a handling handshape is used with a plain verb, it results in the object being shifted. This is exactly what has been documented for ASL with the exception that handling verbs are judged by some consultants as not needing to after the object. The resulting paradigm seen in ASL is as follows:

SVO word order with a plain verb: grammatical
SOV with a plain verb: ungrammatical
SOV with a handing verb: grammatical

The third generalization is that the most common sentence type in sign language has one new one argument that comes before a verb (e.g., SV). The fourth generalization states that regardless of grammatical function or theta role, in locational sentences with two noun phrases, the larger, more immobile object will precede the smaller, more mobile object (also known as the figure-ground principle (see Talmy for spoken languages and Happ & Verköper (2006) for sign languages). The fifth generalization claims that the object is immediately adjacent to the verb (unless the object is topicalized resulting frequently in OSV order). The sixth and last generalization is that SVO order is preferred for reversible sentences with plain verbs.

Napoli and Sutton-Spence (2014) discuss both the generalizations due to universal pressures (amodal account) and generalizations due to modality (modal account). However, the amodal account can only account for some of the generalizations while the modal account is able to capture all of the generalizations. The authors suggest, along with evidence from neuroscience

experiments, that the human sensorimotor-system may have motivated the hierarchical structure of universal grammar. From an evolutionary standpoint, "pressures of both the auditory and visual systems are behind the universal pressures on word order, we can view the sensorimotor pressures as motivating this particular part of universal grammar, which is apparent in both spoken and sign language" (Napoli & Sutton-Spence 2014: 9). This claim is important because it suggests that sign languages exploit these visual pressures not merely because the language is produced visual-gesturally but rather to better align both syntax and semantics. These cross-linguistic generalizations further support observations, however scarce, that have been made about word order in ASL.

2.5 Theory & Bilingualism

In order to understand and faithfully represent the effects of bilingualism on word order, it is necessary to first establish the role of bilingualism in a theoretical framework. Intrasentential code-switching, or language mixing within sentential boundaries, has been studied for insights on the organization of bilingual grammar. Unlike models that propose constraint-based approaches, MacSwan (2000, 2010) offers a constraint-free approach that does not require special mechanisms to account for bilingual knowledge. For example, the Matrix Language Model (Myers-Scotton 1993) proposes special grammatical constraints that come into play only in bilingual contexts and which depend on variable constructs like language dominance.

MacSwan's approach, in line with the Minimalist Program (Chomsky 1995), which by definition privileges simple (economical) explanations over complex ones, there are only two components of grammar: a computational system (CHL) and a lexicon. The computational system is invariant across human languages, while the lexicon contains language-specific idiosyncratic information. Thus, all types of utterances produced by bilinguals can be explained

in terms of adhering to the grammar of a specific language or in terms of principles and requirements of the grammars in interaction.

Language mixing is simply the result of drawing from two lexicons in the course of a single derivation. In this model, items are selected from the lexicon of either language, introducing features that must be checked with elements from either language, mirroring the requirement for monolinguals. This elegantly eliminates the need for a mechanism that would be tasked with reconciling contradictory requirements of the mixed systems. MacSwan posits, "all grammatical relations and operations which are relevant to monolingual language are relevant to bilingual language" (2000:43). Therefore, there are no specialized bilingual constraints. We can extend the spirit of MacSwan's argument to modality: there should be no specialized constraints or machinery needed to account for bimodal bilingualism that are not also present for unimodal bilingualism. The following model, the *Language Synthesis Model*, shown in Figure 2.2, integrates bimodal bilinguals ability to acquire two grammars but also their unique ability to produce features from each simultaneously with two different sets of articulators. This creates a model that adequately describes phenomenon resulting from monolingualism or bilingualism as well unimodal bilingualism or bimodal bilingualism.

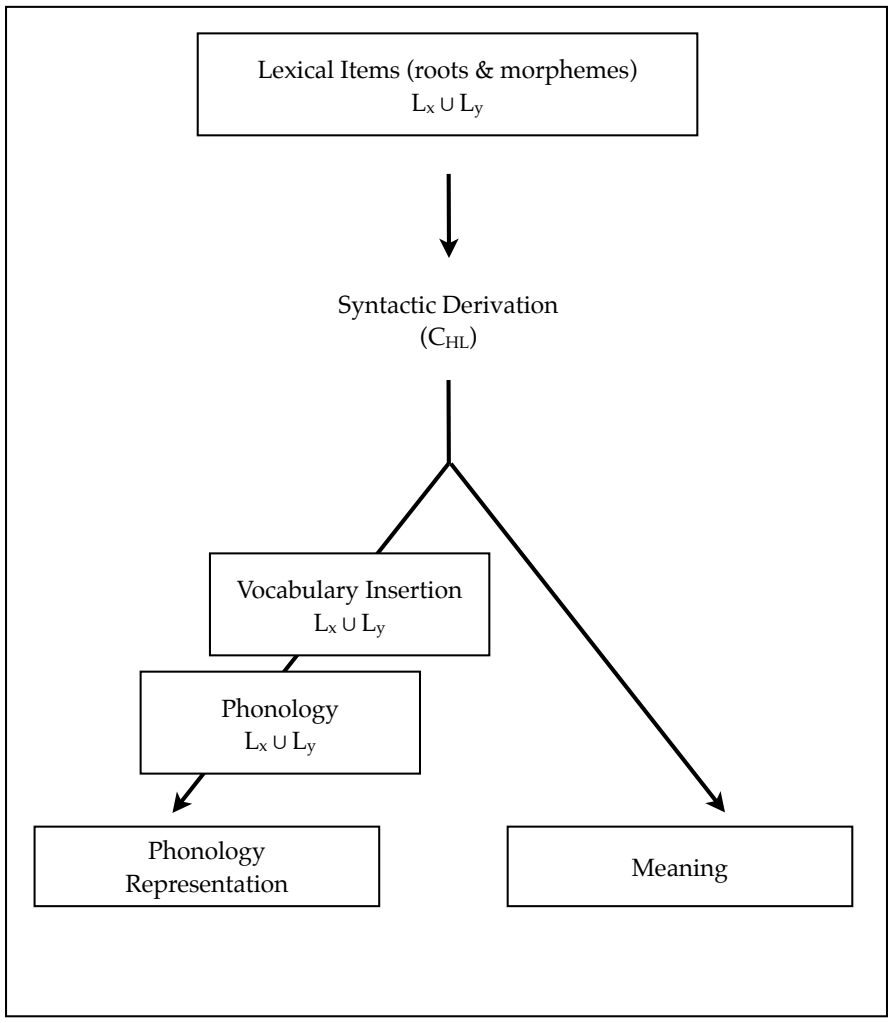
2.6 The Language Synthesis Model

Koulidobrova (2012) and Lillo-Martin et al. (2012) propose a Language Synthesis model (Figure 2.2) that follows the conceptual arguments of MacSwan (2000) and additionally adopts elements from the Distributed Morphology framework (Halle & Marantz 1993). This allows two points for language mixing to take place: (i) during the selection of roots and features, or (ii) late in the derivation during vocabulary insertion. Syntactic transfer is root and morpheme selection from Lx to Ly at (i). Code-switching is the result of vocabulary selection from Lx to Ly at (ii).

Language synthesis for bimodal bilinguals consist of three types: code-switching, syntactic transfer, and code-blending. Code-switching involves a switch between more than one language intra- and inter-sententially. For example, in (7) Eli is unable to fingerspell the name of his friend, stops signing mid-utterance with his father, and instead simply speaks the name of his friend in English.

Syntactic transfer involves using a syntactic structure from one language with lexical items from the other language. For example, in ASL doubling of wh-phrases is allowed for focus. The WH-words appear in both sentence-initial and sentence-final position (Petronio and Lillo-Martin 1997). In this example (8), Ben is using ASL doubling structure with English words (Lillo-Martin et al. 2012). This is an example of unimodal transfer (i.e., the child is speaking only, with no accompanying sign), however, bimodal code-blended mixes are possible as well.

Figure 2.2: Language Synthesis model (Koulidobrova 2012, Lillo-Martin et al. 2012).



(7) Alex
IX(self) FRIEND PUSH IX(self)
'My friend Alex pushed me.'
(Eli 3;00)

(8) Where balloon where?
' 'Where is the balloon?'
(Ben 2;02)

Lastly, code-blending refers to the simultaneous output of elements from both a sign language and a spoken language. In the following example (9), Eli signs and speaks at the same time.

(9) hurt my elbow
HURT IX(self) IX(elbow)
'I hurt my elbow.'
(Eli 3;00)

In accordance with the framework proposed, this investigation will assume that the effects of bimodal bilingualism on ASL word order can manifest as any or all of the above three mechanisms. The adoption of this model serves to underscore that a bilingual's two grammars are separate but not completely isolated from each other. The child must acquire the lexical items of both their languages and all the features associated with those items. This has relevant implications for word order as explained by MacSwan (2000:44):

> The difference between an SVO language like English and an SOV language like Korean, for instance, is defined in terms of the strength of features in the object DP (determiner phrase) (weak in English, strong in Korean).

Features encode information such as number, gender, person, focus, case, et cetera. Strong features must be checked immediately resulting in movement and potential word order change. Weak features are checked later in the derivation. In this way, strong and weak features can account for word order variation. For example, in (3) the final wh-word is realized with a focus feature that in ASL allows it to appear in C. This is not permissible in English; however, the child has seemingly utilized a structure with this feature from his ASL inventory and chosen to satisfy that feature with a vocabulary item from English.

2.7 Bimodal Bilingual Language Differentiation & Interaction

The literature on spoken language bilinguals makes several generalizations about what type of structures are candidates for cross-linguistic transfer. However, these generalizations have not been fully tested with bimodal bilinguals. These children exhibit evidence of cross-linguistic influence in domains not attested in the unimodal bilingual literature. This section will review these findings regarding bimodal bilingual language differentiation and interaction. As predicted by the Language Synthesis model (Lillo-Martin et al 2010; Koulidobrova 2012; Chen Pichler et al. 2014; Lillo-Martin et al. 2012) the language faculty makes forms from both languages available and children simply make use of those forms. This suggests that structures from sign language will occasionally appear in the spoken language and, vice versa, that structures from the spoken language will also appear in the sign language. This model has yet to be tested against all areas of cross-language influence but has thus far demonstrated the ability to explain cross-linguistic transfer, code-switching, and code-blending even in adulthood.

In addition, findings to date have led to two broad generalizations. The first generalization is that with increasing age bimodal bilingual children are learning how to suppress language synthesis in their production (Chen Pichler et al. 2014). The second generalization is that bimodal bilingual children do not necessarily outgrow the effects of language synthesis (Lillo-Martin et al. 2012) because there are several sociolinguistic contexts where such effects are socially acceptable. This is mainly in ASL-English bilingual contexts with adult bimodal bilinguals who identify themselves as Coda and welcome code-blending and Coda talk as a form of in-group speech (see Preston 1995; Bishop, 2005, 2006, 2008 & 2010; Emmorey et al. 2008). This is also accounted for by the language synthesis model. Language synthesis, in various

forms, is not confined to developmental stages. Instead the model predicts that language synthesis remains an option in the adult grammar as well (Lillo-Martin et al. 2013).

The most up-to-date findings regarding bimodal bilingual language interaction include work on null arguments, adjective-noun ordering, and wh-questions. Koulidobrova (2012) investigated the omission of null arguments in the speech of ASL-English bilinguals. This is an intriguing domain of investigation because ASL allows both null subjects and objects while English does not. The author compared two bimodal bilingual children (Tom and Lex from the Development of Bimodal Bilingual Project) with a unimodal bilingual control (Carlo). Previous literature (Serratrice el al. 2004) had demonstrated that Italian-English bilingual Carlo did not differ from monolinguals in supplying obligatory subjects and objects in his English utterances. In fact, much like monolingual English speakers, Carlo was able to quickly overcome an initial stage of argument omission without delay. Tom and Lex differ from Carlo in that they display a much higher rate of subject and object omission in their English. This also occurred in previously unattested contexts such as following a modal (10) and in an embedded clause (11).

(10) Tom: Can Ø give me this?
'Can you give me this?'

(Koulidobrova 2012: 21)

(11) Lex: Mister Conductor said Ø won't crashed# he said
'Mister conductor said that it wouldn't crash; that's what he said.'

.

(Koulidobrova 2012: 228)

In a follow-up investigation of the rate of null argument omission in Tom and Lex's spontaneous productions of ASL, Koulidobrova (2013) found that these children omit subjects 23-37% of the time. This echoes patterns documented in adult signing ~35% (Wulf et al. 2002).

Tom and Lex did not oversupply overt subjects in their ASL productions contrary to what has been seen with many unimodal bilinguals. English-Italian unimodal bilinguals oversupply subjects in the target null argument language Italian (Serratrice et al. 2004). Interestingly, Spanish-Italian bilinguals (both null argument languages) also accept overt subjects in inappropriate contexts (Sorace et al.2009, Sorace 2011). This has led researchers to posit that this effect cannot be the result of cross-linguistic transfer but instead is a more general effect of bilingualism. However, such over-suppliance is unattested in bimodal bilingual spontaneous production. Reynolds (2015) has found evidence for the over-suppliance of overt noun forms in bimodal bilingual elicited ASL narratives.

To summarize, bimodal bilingual development potentially displays acquisition patterns that have not been attested among unimodal bilinguals. For this reason, bimodal bilingual data provide an important opportunity to refine and test theories of language development. They have a much higher rate of null argument omission in English than both monolingual children and spoken language bilinguals. In addition, there seems to be no effect whether it be cross-linguistic transfer or a general bilingualism on the production of overt subjects in the children's ASL (at least as evidence in naturalistic data). Instead the children demonstrate that they omit null argument in adult-like ways. These findings offer evidence for the explanatory power of the language synthesis model in capturing various forms of language interaction.

2.8 Variable Word Order and Bilingualism

Early reports of ASL word order acquisition include Hoffmeister (1978), an analysis of spontaneous ASL production from three deaf children. He reported between 17-33% production of noncanonical VS order and 40-42% noncanonical OV order, yet concluded that deaf children

go through a fixed word order stage, and at 24 months only begin to learn how to use inflected ASL verbs that often occur with noncanonical word orders.

One objective of the study conducted by Chen Pichler (2001) was to test previous claims that deaf children go through a fixed word order stage. Chen Pichler (2001) was able to show that the four deaf children in her study were using VS structures licensed by subject-pronoun copy (Padden 1983) and OV structures licensed by aspectual, handling and spatial morphology (reordering morphology) or, in the case of one child, early topicalized objects marked with simple prosodic breaks between the object and verb. Based on the Chen Pichler (2001) account, it is evident that deaf children exposed to ASL's variable word order are able at a young age to produce both canonical and noncanonical word order. The literature on monolingual children acquiring word order indicates that for some languages children appear to go through a fixed word order stage while with other languages the children acquire all the variable word orders without going through such a period. Turkish children acquire all six word order variations by the age of 2;0 years of age (Slobin, 1982, Ekmekçi 1986). Slobin (1984) proposes that the robust and consistent inflectional system in Turkish that clearly identifies subjects and objects allows children to quickly acquire all the word orders permissible in Turkish.

However, in English (McNeill 1966, Brown 1973) Russian (Gvozdev 1949, 1961), Korean (Park 1970, Cho 1981) and Chinese (Erbaugh 1992) it has been reported that children go through a period in which they do not use the variable word orders they are exposed to and instead rely heavily on just one (often the canonical word order but not always the case, e.g., Russian). Erbaugh (1992) reports that children learning Chinese adhere to SVO order until after their third birthday. This is despite consistent evidence from object fronting with constructions involving object and passive marking, and due to discourse-oriented topicalization.

Taken together, previous studies indicate that a rich and consistent morphological system, as is the case with Turkish, allows children to acquire variable word order quite quickly. When the morphological system is less consistent the results are much more varied. One possibility is that when exposed to a variable word order, children initially rely on a conservative hypothesis; that is, despite some evidence in support of word order flexibility, the children cling to one word order until enough evidence is supplied in the input encouraging them to reevaluate their initial assumption. To rephrase, variable word order acquisition seems to be largely dependent on the type of cues provided and possibly a certain threshold of input received. Cross-linguistic analysis of monolingual children acquiring variable word order languages is one way to test the strength of certain cues. This could be done examining the consistency of morphological features in conjunction with the saliency of pragmatic cues, which indicates the motivation for the noncanonical orders. However, determining the input threshold using monolingual data may prove quite difficult. Bilingual children acquiring at least one variable word order language will inherently have less input in both of their languages as compared to monolinguals. If the amount of input is a crucial factor in the acquisition of variable word order then we can expect bilinguals to diverge. In the following section, literature to date on bilingual acquisition of variable word order will be reviewed.

As explicated by Chen Pichler (2001), ASL's morphological system is not nearly as consistent in comparison to Turkish. We might have expected that deaf children exhibit a period of fixed order as Korean, Russian and Chinese children do; but on the contrary, deaf children acquire noncanonical word order at a very young age. This suggests that the factors driving the saliency of variable word order in ASL are still robust enough in the bilingual context for

children to avoid the fixed word order stage, although additional research is needed on this question.

As with the data presented on monolingual word order acquisition, the results from bilingual word order acquisition are split. When there is no overlap for a specific construction between the two languages being learned, it appears that the contrast is detectable and bilingual children acquire both constructions easily. For example, Paradis and Genesee (1996) found that young French-English bilingual children correctly place verbal negatives after lexical verbs in French (e.g., "n' anime pas") and negation words post-verbally in English (e.g., "do not like") and at the same age as monolinguals acquiring these languages.

However, other bilingual word order studies suggest that the acquisition of conflicting word order across the two languages is not nearly so seamless. Schlyter and Håkansson (1994) studied six French Swedish bilinguals of whom half were claimed to be Swedish-dominant and the others French-dominant. In all of the cases, at least one language was acquired without any problems, i.e., it was acquired in the same way as by monolinguals, while the weaker language showed varying degrees of divergence. Swedish, unlike modern French, is a verb-second (V2) language (like many other Germanic languages with the exception of English). In Swedish, subject-verb inversion is obligatory for yes-no questions and in cases where the subject is a topic. In Schlyter and Håkansson (1994), the three bilingual children with Swedish as the stronger language patterned with Swedish adult native speakers and monolingual children, whereas the three children with Swedish as their weaker language did not place the verb second as much as the monolingual children. In this example, not all of the bilinguals successfully acquired the Swedish verb-second rules and language dominance was offered as an explanation.

However, language dominance is not fully explanatory for all bilinguals. In a study of Ukrainian-English bilinguals Mykhaylyk (2009) examined object shift in Ukrainian. English and Ukrainian have the same basic word order (i.e., SVO). In Ukrainian SVO can be used with indefinite and definite objects, but there is also the option for the direct object to occur in pre-verbal position. While specific (definite) objects can occur in SVO order, they frequently occur in SOV order due to object shift. Mykhaylyk found that monolingual children increased their use of object shift as a function of age while the bilingual children decreased their use of object shift with age. There are important points to consider from the bilingual literature presented here. The first, from the work on Swedish-French bilinguals, that the overall total usage of a particular construction could be affected by language dominance. However, Meisel (2007) aptly points out that a difference in the percentage of use of word order between L1 and bilingual children (with Swedish as a weaker language) does not necessarily indicate a lack of acquisition of the V2 parameter in this case.

2.9 Research Questions

This dissertation aims to add to the existing research on bilingual acquisition of a fixed and variable word order language. This study seeks to determine whether the factors that traditionally affect bilingual word order acquisition are still applicable when the languages are in different modalities. It is also largely motivated by the fact that variable word order in ASL, despite being easily acquired by deaf children at an early age (Chen Pichler 2001), is a likely candidate for cross-linguistic influence because of both the structural overlap between the languages and the fact that noncanonical word orders in ASL are motivated by morphological features and vulnerable to input effects. Accordingly, the research questions guiding this study are the following:

Do the bimodal bilingual children produce the same amount and type of word orders as native-signing deaf children from deaf families?

What factors influence the bimodal bilinguals' word order production?

As will become apparent in the next two chapters, addressing these research questions first requires careful consideration of the effects of bimodality on children's output, demonstrating the importance of bimodal bilingual data for a comprehensive understanding of early word order development.

CHAPTER 3 METHODOLOGY

3.1 Participants

The children in this study are part of an ongoing specialized corpus project: The Development of Bimodal Bilingualism[2] (Chen Pichler et al. 2013, Quadros et al. 2014). These children have participated in experimental studies and have been filmed longitudinally for an extended period of time. For all of the children, the home language is ASL, a signed language, but the children receive input to English, a spoken language, through relatives and the community. The children included in this study are Ben, Wiz, Jem and Eli.

> Ben is a hearing male child with two deaf parents, one deaf older sibling and one hearing older sibling, one deaf grandparent (who learned sign language in graduate school) and three hearing grandparents. Ben's home environment can be characterized as predominantly ASL but sign-speech blending also occurs. Ben's mother was born deaf and his father lost his hearing in his early teens; both learned ASL in early adulthood. Ben's mother reports Ben is a balanced bilingual.
>
> Wiz is a hearing male child with one deaf parent and one hearing parent. All of his extended family are hearing. Wiz's home environment can be characterized as predominantly ASL but sign-speech blending also occurs. Wiz's (Deaf) mother mostly uses ASL without blending while Wiz's (hearing) father usually blends. Wiz's mother was born hearing and became deaf at 8 months old; she was exposed to sign language at a very early age. Wiz's father acquired ASL after meeting Wiz's mother, before Wiz was born. Wiz's mother reports her son is spoken English dominant but also considers him fluent in ASL.
>
> Eli (male) and Jem (female) are the second and third children from a single deaf family. They were born profoundly deaf, and both received bilateral cochlear implants at an early age. Jem received her first implant at 11 months of age and the second at 14 months of age. Eli's cochlear implants were activated at 13 and 23 months. They have two deaf parents, and their extended family is all hearing. Their mother was born and raised in Poland and relied on lip-reading and speaking Polish to communicate with relatives and in school. She learned

[2] This research was supported in part by Award Number R01DC009263 from the National Institutes of Health (National Institute on Deafness and Other Communication Disorders). The content is solely the responsibility of the author and does not necessarily represent the official views of the NIDCD or the NIH. Support was also provided by awards from the Gallaudet Research Institute.

American Sign Language in early adulthood upon moving to the United States. The children's father learned sign language as a young child. They have one older brother who was also born profoundly deaf and received bilateral cochlear implants at a very young age. Impressionistically, both children present as nearly indistinguishable from the hearing children with deaf parents in terms of speech quality. According to an aural rehabilitation report when Jem was age 2;01 she scored within the normal ranges on a standardized English receptive and expressive test (table of results in Appendix A). Their home environment can be characterized as predominantly ASL but a large amount of sign-speech blending by the mother occurs and all the children speak English (without signing) to each other. Jem attends a daycare where English is used exclusively, but also attends a school for the deaf one day per week. Eli attended the same daycare but attended a school for the deaf full-time between the ages of 3 and 4. Their mother reports that both children are English dominant but sign very well.

3.2 Data Collection

All data for this study came from the Development of Bimodal Bilingualism longitudinal video archives. The archives contain video-recorded sessions of children taken in their homes or at Gallaudet University, alternating between English-targeted and ASL-targeted sessions on a regular basis for 2-4 years. During sessions, children engage with research assistants or parents, playing with toys, reading books, or playing games in a naturalistic manner. The purpose was to elicit natural language use and to let language mixing occur spontaneously; adult interlocutors did not try to enforce language separation (see Chen Pichler et al. 2013 and 2015 for more detail about our filming methods). Transcription of video recordings minimally included utterance-level annotations that consist of all lexical items produced by the child and any adults in the session. In addition, some information is available regarding context and logistics of individual filming sessions from the field notebooks kept by the research assistants.

For the purposes of the present study, selected ASL-target sessions were chosen for analysis. In Table 3.1 a list of the sessions included in this dissertation data set are presented by child. The table provides information on the session name of the transcript, the duration of the video session, and the age of the child.

Table 3.1: List of videos used in the dataset by child

Child 1: Ben		
Transcript	**Minutes**	**Age (in months)**
Ben 015	47	20.25
Ben 016	36	21
Ben 019	31	22.75
Ben 024	28	23.25
Ben 030	30	25
Ben 042	44	29
Ben 045	41	30.25
Ben 051	44	31.50
Ben 061	57	33
Ben 073	24	35.5
Ben 075	55	36
Ben 091	41	40.5

Child 2: Wiz		
Transcript	**Minutes**	**Age (in months)**
Wiz 27	47	21.75
Wiz 35	43	24.5
Wiz 37	35	25
Wiz 42	47	27.75
Wiz 46	39	29.5
Wiz 50	50	30
Wiz 52	52	33
Wiz 54	54	34.5
Wiz 56	44	35
Wiz 58	38	36
Wiz 64	31	38
Wiz 68	48	39
Wiz 70	64	40

Child 3: Eli		
Transcript	**Minutes**	**Age (in months)**
Eli 001	55	32
Eli 003	43	33.5
Eli 006	48	35
Eli 009	26	36
Eli 015	56	39.75
Eli 017	69	40.5
Eli 019	59	42.25

Child 4: Jem		
Transcript	**Minutes**	**Age (in months)**
Jem 21	17	19
Jem 40	33	25.25
Jem 45	27	26.5
Jem 46	35	27.75
Jem 51	31	28
Jem 53	35	28.75
Jem 57	31	30
Jem 59	44	31.75
Jem 61	56	32.75
Jem 63	44	34.5
Jem 65	55	38

3.3 Transcription

Transcription was completed by the author or other research assistants following the conventions described in Chen Pichler et al. (2010). This included using the ELAN program[3] (Crasborn and Sloetjes 2008) to create annotations that are time-aligned to the video files. Whenever possible transcripts already created by the laboratory were used for this study. The general research laboratory procedure was for hearing assistants to transcribe the spoken language used by the participants in the video, then for assistants native or near-native in ASL to transcribe all the sign language utterances on separate tiers. When a transcript was not available for analysis, the author, a hearing native signer, transcribed all two-word utterances containing a verb.

3.4 Determining Utterance Breaks

One of the most challenging aspects of transcription was determining utterance breaks. There are various non-manual and manual markers used in ASL that indicate both prosodic and syntactic boundaries. Prosodic cues in sign language can occur sequentially or simultaneously. Various non-manual features have been explored throughout the literature (eye blinks by Wilbur 1994, 1999; Nespor & Sandler 1999; Baker & Padden 1978, brow movements: Sandler 1999; Nespor & Sandler 1999, eye gaze by MacLaughlin 1997, body leaning by Brentari & Crossley 2002; Wilbur & Patschke 1998, relaxing of the hands by Chen Pichler et al (2010), pauses and holds by Nespor & Sandler 1999). An experimental study conducted by Fenlon et al. (2007) showed that even sign-naive viewers are sensitive to prosodic patterns marking utterance boundaries. Similar findings have been reported by Brentari et al. (2010) and Mesh (2012). As

[3] developed by the Max Planck Institute for Psycholinguistics, The Language Archive, Nijmegen, The Netherlands:http://tla.mpi.nl/tools/tla-tools/elan/

has been suggested by other authors (e.g., Nespor & Sandler 1999), boundaries are marked by simultaneous changes in one or more prosodic feature but with great variability with respect to composition; in their study, the number of cues present at a boundary varied from two to eight. In a similar study by Hochgesang (2009), native and near-native signers were asked to segment a short ASL narrative. By and large, segmentation was clustered close to where linguistics segmented utterances but overall there were significantly fewer boundaries posited by the non-linguists. This suggests that, at least in part, the criteria linguists use for determining utterance breaks is supported by native signers' intuitions. For this study, eye gaze, eye blinks, drop of hands as well as holds and pauses were used to determine utterances breaks. Eye gaze or eye blinks as evidence of a prosodic break was used with caution; eye behavior for linguistic purposes is often non-adult like at such an early stage. In addition to prosodic information, propositional information was used to determine utterance breaks. Rather than using purely prosodic information argument structure helped to inform the boundaries of syntactic units. For example, if a transitive verb was identified followed by a point.

3.5 Data Selection Criterion

ASL-target sessions were selected from the corpus between the ages of 19 and 40 months (Table 3.2). For analysis, the data were divided into two categories: very early word order (19-30 months) and early word order (30-40 months). The very early word order category is age-matched with Chen Pichler's (2001) study of deaf-parented deaf children for a straightforward comparison. The current study extends to beyond 30 months, the early word order category, to investigate any trends that may be protracted since the target population is bilingual.

For the selection of utterances to be included in the analysis, imitations and repetitions were excluded. Only utterances that contained a verb and an overt argument were included in the

data set, since these are the relevant utterances for determining whether the children have acquired canonical order and learned to modify them in grammatical ways. This means that the initially very large dataset was narrowed considerably before analysis even began. As described above, pauses and other indicators of utterance breaks were carefully considered to ensure verbs and their corresponding arguments were part of the same syntactic unit.

3.6 Indexical Pointing

Utterances that consisted solely of an index (i.e., point) in conjunction with an NP were excluded from analysis, since I only included utterances with a clear verb, subject and/or object,. Unclear points were also excluded from the data set due to their ambiguity. However, there are two cases where indexical pointing was analyzed. The first is when pointing was clearly functioning as a pronoun, in conjunction with a verb. This means the index was directed toward a clearly identifiable entity that could be considered an argument of a verb. Points that are vaguely directed toward an entity (without accompanying eye gaze or body lean) were not analyzed. The second case was when the children blended or produced an index with audible English. The accompanying English at times helped determine if the point was functioning as a pronoun, which could be analyzed if the utterances also contained a verb (either signed or spoken). For example, as illustrated in (12), the child says the English pronoun “he” while pointing to a character in a book. In such a case, the IX would be counted as the subject of EAT/is eating.

(12) Subject indexical point

he's eating
IX(character-in-book) EAT
'He's eating.'

(Wiz 3;02)

	
He's IX(character-in-book)	eating EAT

3.7 Coding: Modality & Word Order

Only utterances that included a verb and at least one argument were included for analysis. An utterance could be completely in one language or be a switch between modes (i.e., English to ASL and English produced simultaneously), illustrated in (13) and (14) respectively. The utterances can also be fully bimodal where the child is producing ASL and English at the same time as in (16). In order to make direct comparison with the results from Chen Pichler (2001), the first type of utterances were labeled *ASL only*, and remaining utterances were labeled *Partially Bimodal*, or *Fully Bimodal*, or *English Only* for separate analyses. This coding was done on tiers added to the existing Development of Bimodal Bilingualism ELAN template. The criterion for the bimodal label is similar to that adopted by Lillo-Martin et al. (2014); to be counted as bimodal, the target utterance had to be comprised of both sign language and spoken language (fully voiced or whispered). However, this analysis parceled out the fully bimodal utterances from the partially bimodal utterances. If the verb and arguments of an utterance were voiced and signed, that utterance was considered fully bimodal. An utterance was still considered

fully bimodal if words other than the noun head and verb were not blended. Thus, in fully bimodal utterances, the major clausal constituents (S, V and O, if present) are produced in both languages simultaneously, with the relation between the verb and the arguments expressed in both the English and the ASL. The partially bimodal utterances might be considered code-switches if we consider switching from one language to blending or vice versa as a type of code-switch, however, here they will just be considered language-mode switches. True code-switches, in which the child switches from one language to another (without blending) did not occur in this data set. The purpose of distinguishing between ASL-only, partially bimodal and fully bimodal utterances is to investigate whether the type of language mixing has any influence on the word orders the children produced.

(13) ASL-only utterance

BOY GO
S V
'The boy is going.'

(Ben 2;05)

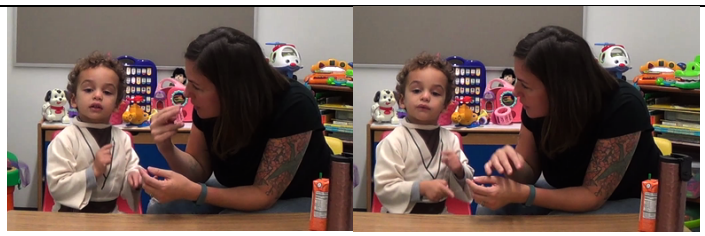


BOY	COME

(14) Partially-blended utterance

FRIEND
see friends
V O
'I see friends'

(Wiz 3;00)

	
see	FRIEND friends

(15) Partially-blended utterance

EAT IX(drawing)
eat
V S
'He's eating"

(Wiz 2;09)

	
EAT eat	IX(drawing)

(16) Fully-blended utterance

DRUM, DRUM BRING
drum he brought me
O V
'He brought me a drum'

(Eli 3;06)

	
DRUM drum	BRING[spatial] drum he brought me

Each annotation was labeled for word order. Thus, (13) was labeled SV for subject-verb order; (14) was labeled VO for verb-object order; and (15) was labeled VS for verb-subject order; and finally (16) as object-verb order. Thus, each utterance was labeled for word order (i.e., SV, VS, VO, OV). If an utterance included a subject, verb and object that utterance would count for two word orders. Therefore, an SVO utterance would be categorize as both SV and VO. Likewise, a SVS word order would count as an SV and a VS. In addition to determining the word order, each utterance was judged for grammaticality. The following criterion (outlined by Chen Pichler 2001 and previous researchers) was used to determine grammaticality of noncanonical word orders:

VS utterances with a final subject in pronoun form with a confirmational reading

OV utterances with reordering morphology (spatial, handling, instrument, aspect) associated with the verbs

The initial labeling strictly followed this criterion and all canonical word orders were considered grammatical. After this first pass, additional reasons for OV ordering were considered and error rates were adjusted (see Discussion Chapter).

The number of utterances included in this dataset for analysis are provided in Table 3.2. The table provides the session number and the age and months followed by the number of utterances that met the verb plus at least one argument criterion. The strict criterion excluded many of the two-sign utterances that the children produced. For example, in a session with Ben (age 2;04) and a deaf research assistant, the children produced 164 two-sign utterances. After the criterion was applied only 27 remaining two-sign utterances were coded for word order and included in the final dataset.

Table 3.2: List of utterances meeting criterion (verb plus at least one argument) by session number for each child

Child 1: Ben		
Transcript	**Age (in months)**	**Number of Utterances Included**
Ben 015	20.25	3
Ben 016	21	5
Ben 019	22.75	3
Ben 024	23.25	3
Ben 030	25	4
Ben 042	29	27
Ben 045	30.25	20
Ben 051	31.50	17
Ben 061	33	24
Ben 073	35.5	8
Ben 075	36	22
Ben 091	40.5	58

Child 2: Wiz		
Transcript	**Age (in months)**	**Number of Utterances Included**
Wiz 27	21.75	0
Wiz 35	24.5	0
Wiz 37	25	0
Wiz 42	27.75	3
Wiz 46	29.5	0
Wiz 50	30	5
Wiz 52	33	8
Wiz 54	34.5	1
Wiz 56	35	7
Wiz 58	36	5
Wiz 64	38	28
Wiz 68	39	6
Wiz 70	40	17

Child 3: Eli		
Transcript	**Age (in months)**	**Number of Utterances Included**
Eli 001	32	3
Eli 003	33.5	10
Eli 006	35	14
Eli 009	36	45
Eli 015	39.75	10
Eli 017	40.5	10
Eli 019	42.25	8

Child 4: Jem		
Transcript	**Age (in months)**	**Number of Utterances Included**
Jem 21	19	6
Jem 40	25.25	7
Jem 45	26.5	3
Jem 46	27.75	7
Jem 51	28	0
Jem 53	28.75	2
Jem 57	30	2
Jem 59	31.75	2
Jem 61	32.75	20
Jem 63	34.5	19
Jem 65	38	7

3.8 Analysis Post-Transcription and Coding

After transcribing and coding were completed, the following tiers were exported from ELAN as tab-delimited text. Each tier was assigned a separate column with each annotation time stamped. The following tiers were exported:

Child ASL Utterance
Child English Utterance
ASL Only Word Order
Partially Blended Word Order
Fully Blended Word Order

The text file was opened, copied and pasted into a spreadsheet program. A separate sheet was prepared for each child, and a separate table for each session. The author built a COUNTIF formula for each column to ensure accuracy when counting word order types and a formula to calculate percentages.

3.9 Determining Age of Acquisition

Studies of language acquisition establish criteria to determine when a child has acquired a particular syntactic component. One frequently used measure is mastery, defined in terms of the percentage of time a child uses the target structure studied in obligatory contexts. The researcher normally establishes the percentage before analyzing the data; in the case of Brown (1973), this criterion was set at 90%. Stromswold (1989) examined 12 children's production of infinitivals, exceptional case-marking constructions, double-object datives, questions with preposition stranding, and passives with prepositions stranding in the CHILDES database (MacWhinney 2000). She found that the two measures she developed, i) age of first use defined as the first clear instance of use that is not an imitation or a routine, and ii) age of repeated use defined as used twice in one month or used five times during the period of study, and were highly correlated for all five constructions.

Synder (2007) adopts Stromswold's acquisition measure more conservatively by combining the two criteria as *First of Repeated Use* (FRU): "first clear use, followed soon after by regular use" (71). Since it is difficult to pinpoint the contexts when ASL noncanonical word orders are required, the two Stromswold measures were applied to the data collected for this study. In addition, these measures were applied to the data from deaf of deaf children presented in Chen Pichler (2001). The first-use and repeated-use measures will provide a quantifiable means for comparing the deaf and bimodal bilingual children to determine the age at which noncanonical word orders were acquired (which is significant for determining mastery).

3.10 Statistical Analysis

A linear mixed-effects statistical model was used containing both fixed and random effects. This type of model is particularly useful with longitudinal studies because measures are repeated over time in addition to being statistically rigorous. Mixed models are being increasingly adopted by linguists (e.g., Caselli et al. 2015) and becoming more preferred over traditional approaches such as repeated measures ANOVA because they are more effective in dealing with missing values, and they provide more flexibility in examining explanatory variables. Using the statistical program R[4], analyses were computed using the *lme4* package (Bates et al. 2014). In each analysis the baseline, or dependent variable, is the number of utterances produced. The explanatory variables include age, hearing status, and word order type. For word order effects, the comparison variable is either VO (usually the first table presented) or SV (usually the second table presented). For hearing status, the comparison variable is bimodal

[4] R Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

bilinguals. According to Vasishth et al. (2008), fixed effects can be judged from the absolute *t*-value. If the *t*-value is higher than 2, then the factor is significant.

CHAPTER 4 RESULTS

4.1 Introduction

The data from Ben, Wiz, Jem and Eli were analyzed to determine whether or not bimodal bilingual children produced ASL variable word order similarly to the natively signing deaf children from deaf parents as reported in Chen Pichler (2001). This comparison consists of several components: an analysis of the percentages for canonical and noncanonical word orders for the ages sampled (Section 4.2), the developmental trajectory for various word order combinations (Section 4.3), and a measure of acquisition as determined by first-repeated use (Section 4.4). While at first glance it may appear that the bimodal bilinguals greatly diverge in their acquisition of noncanonical orders when compared to deaf controls, closer examination reveals that they are acquiring features of ASL grammar but their acquisition path and timetable presents differently from that of the deaf comparison group. As will be explained later in this chapter, it appears that combining all utterances that include signing is required for understanding the word order production in bimodal bilinguals.

4.2 Percentages for Canonical and Noncanonical Word Orders

A wealth of research suggests that bilingual children reach many developmental milestones at the same time as monolinguals (e.g., functional categories Paradis & Genesee 1996, total vocabulary Hoff et al. 2011), including previous studies on bimodal bilinguals (Petitto et al. 2001, Petitto & Kovelman 2003) as well. But there is also a growing body of evidence that presents a more nuanced view and asserts that bilingual language development is paced by input the children receive (Hoff 2006, De Houwer 2009). To allow for the possibility that bimodal bilingual children simply take a little longer to develop the same word order flexibility observed in Chen Pichler's (2001) subjects, the time period sampled for the bimodal

bilinguals in the current study this study was extended by 10 months. Thus, the subsequent results will make age-matched comparisons with the deaf children from Chen Pichler (2001) for 20-30 months, as well as a second set of comparisons for 20-40 months.

In addition, language mode will be carefully considered. Language mode for this study is defined as the production of one language, either spoken or signed or the production of sign and speech simultaneously. Only ASL utterances were analyzed in Chen Pichler (2001) and the author does not recall any appreciable speech in the sessions studied (D. Chen Pichler, personal communication, October 20th, 2015). In contrast, the bimodal bilingual children frequently produce both ASL-only utterances as well as blended utterances (i.e., utterances that are signed as well as spoken in English). For the sake of accurate comparison, the bimodal bilingual results will be categorized by ASL-only, blended, and ASL-only plus blended utterances. The ASL-only and blended categories are added together for a more comprehensive look at the bimodal bilinguals' language use. The following tables (Table 4.1) show the percentages of canonical and noncanonical orders reported for the deaf children from Chen Pichler (2001).

Table 4.1: Percentage of canonical word orders from Chen Pichler (2001)

			Verb + Object		Subject + Verb	
Child	Status	Age	canonical VO	noncanonical OV	canonical SV	noncanonical VS
NED	Deaf	25-30	(13/25) 52%	(12/25) 48%	(49/68) 72%	(19/68) 28%
SAL	Deaf	20-26	(14/44) 32%	(30/44) 68%	(27/50) 54%	(23/50) 46%
JIL	Deaf	22-27	(25/50) 50%	(25/50) 50%	(24/33) 73%	(9/33) 27%
ABY	Deaf	22-30	(38/76) 50%	(38/76) 50%	(56/98) 57%	(42/98) 43%
Total			**(90/195) 46%**	**(105/195) 54%**	**(156/249) 63%**	**(93/249) 37%**

On average the deaf children produced OV utterances 54% (105/195) of the time out of all multi-sign utterances that contained a verb and an object. Likewise, on average the deaf children produce VS utterances 37% (93/249) of the time. These raw percentages, in addition to the use of reordering morphology (or for ABY, prosodic breaks between O and V), correlated significantly with noncanonical word order, prompting Chen Pichler to conclude the deaf children had acquired noncanonical word order.

Turning to the bimodal bilingual data in Table 4.2, which shows the percentage of canonical and noncanonical word orders for the bimodal bilingual children, it is immediately evident that between 20 and 30 months there are very few, if any, noncanonical orders. To allow for the possibility of protracted acquisition, the time period under investigation was extended an

additional 10 months. Table 4.3 shows the results for ASL-only utterances from 20-40 months (with the exception of Eli, who did not join the study until age 32 months).

Table 4.2: Bimodal bilinguals ASL-only utterances 20-30 months

			Verb + Object		Subject + Verb	
Child	Status	Age	canonical VO	noncanonical OV	canonical SV	noncanonical VS
Ben	Koda	20-30	(18/18) 100%	(0/18) 0%	(18/18) 100%	(0/18) 0%
Wiz	Koda	20-30	(1/1) 100%	(0/1) 0%	(0/1) 0%	(1/1) 100%
Jem	DDCI	19-30	(4/4) 100%	(0/4) 0%	(5/5) 100%	(0/5) 0%
Total			**(23/23) 100%**	**(0/23) 0%**	**(24/25) 96%**	**(1/25) 4%**

Table 4.3: Bimodal bilinguals ASL-only utterances extended to 20-40 months

			Verb + Object		Subject + Verb	
Child	Status	Age	canonical VO	noncanonical OV	canonical SV	noncanonical VS
Ben	Koda	20-40	(45/46) 98%	(1/46) 2%	(66/71) 93%	(5/71) 7%
Wiz	Koda	20-40	(2/2) 100%	(0/2) 0%	(2/4) 50%	(2/4) 50%
Jem	DDCI	20-34	(11/11) 100%	(0/11) 0%	(17/17) 100%	(0/17) 0%
Eli	DDCI	32-42	(13/13) 100%	(0/13) 0%	(13/14) 93%	(1/14) 7%
Total			**(71/72) 99%**	**(1/72) 1%**	**(98/106) 92%**	**(8/106) 8%**

As indicated by Table 4.3, the ASL-only utterances produced by the bimodal bilingual children are overwhelmingly canonical VO and SV. In Tables 4.4 and 4.5 individual results are collapsed into three groups: deaf 20-30 months, bimodal bilingual (abbreviated Bibi) 20-30 months, and bimodal bilingual 20-40 months. Extending the sample by 10 months does not drastically change the percentage of noncanonical utterances produced, but slight changes can be noted. The first change is the number of utterances that are included in the analysis; the bimodal bilingual children are much more productive after 30 months of age. As a group, the number of verb and object utterances triples and the number of subject and verb utterance more than quadruples. In both instances the number of utterances does not reach the number produced by the deaf children; however, it looks much more comparable than the age-matched 20-30 month age range. The second change, as seen in Table 4.5, is that the number of noncanonical VS utterances

increases. This is not nearly as dramatic as the overall increase in production; however, there is a slight increase in the number of noncanonical orders. In addition to overall percentages, the utterance range is listed in Tables 4.4 and 4.5 to demonstrate the variability in the amount of utterances produced.

Table 4.4: Group comparison V + O (ASL-only utterances)

				Verb + Object	
Group	Age	Total # Sessions	Utterance Range V+O	canonical VO	noncanonical OV
Deaf	20-30	40	25-76	(90/195) 46%	(105/195) 54%
Bibi	20-30	43	1-18	(23/23) 100%	(0/0) 0%
Bibi	20-40 (+10 months)	43	2-46	(71/72) 99%	(1/72) 1%

Table 4.5: Group comparison S + V (ASL-only utterances)

				Subject + Verb	
Group	Age	Total # Sessions	Utterance Range V+O	canonical SV	noncanonical VS
Deaf	20-30	40	32-98	(156/249) 63%	(93/249) 37%
Bibi	20-30	43	1-18	(23/24) 96%	(1/24) 4%
Bibi	20-40 (+10 months)	43	4-71	(98/106) 92%	(8/106) 8%

It is unclear from the previous literature if sampling the ASL-only utterances of bimodal bilinguals effectively captures their ASL grammatical competence, which, in this dissertation, is demonstrated by mastery of all grammatical word orders. Certainly, the total percentage of ASL-only utterances in the bimodal bilingual children's production is very small, suggesting that modality needs to be examined very closely. It has been reported repeatedly in the literature that bimodal bilinguals often code-blend (for adults: Bishop & Hicks 2005, Emmorey et al. 2008, Preston 1995; for children: Kanto et al 2013, Petroj et al. 2013, Petitto et al. 2001, van den Bogaerde & Baker 2005). If blended utterances are excluded, this analysis potentially excludes a large subset of utterances that may be heavily influenced by ASL grammatical features. This strong potential for cross-linguistic influence underlies the Language Synthesis model introduced in Chapter 2. Therefore, in the following section, the strict ASL-only criterion is relaxed and the word orders of blended utterances are included in subsequent analyses.

Tables 4.6 and 4.7 show the number and percentage of canonical utterances occurring in only the blended utterances produced by the bimodal bilinguals at age 20-30 months and 20-40 months. In the early stages of two-word combinations (20-30 months) the number of utterances overall remains the same. That is, the number of ASL-only utterances produced and the number of blended utterances are relatively the same between the ages of 20 and 30 months. In addition to being largely canonical, the children are not yet displaying a language mode preference (i.e., signing only versus signing plus speech). However, this picture changes when we examine the blended word orders for an additional 10 months, which are presented in Table 4.7. As reported for the ASL-only utterances, the number of blended utterances increases dramatically between 30 and 40 months. What differs between the ASL-only and blended utterances between 20-40 months is that overall, there are many more instances of blended utterances.

Table 4.6: Word order patterns in blended utterances 20-30 months

			Verb + Object		Subject + Verb	
Child	Status	Age	canonical VO	noncanonical OV	canonical SV	noncanonical VS
Ben	Koda	20-30	(5/5) 100%	(0/5) 0%	(8/8) 100%	(0/8) 0%
Wiz	Koda	20-30	(3/3) 100%	(0/3) 0%	(2/3) 67%	(1/3) 33%
Jem	DDCI	19-30	(11/11) 100%	(0/11) 0%	(8/8) 100%	(0/8) 0%
Total			**(19/19) 100%**	**(0/19) 0%**	**(18/19) 95%**	**(1/19) 5%**

Table 4.7: Word order patterns in blended utterances 20-40 months

			Verb + Object		Subject + Verb	
Child	Status	Age	canonical VO	noncanonical OV	canonical SV	noncanonical VS
Ben	Koda	20-40	49/49 (100%)	0/49 (0%)	61/62 (98%)	1/62 (2%)
Wiz	Koda	20-40	44/45 (98%)	1/45 (2%)	37/42 (88%)	5/42 (12%)
Jem	DDCI	20-34	24/24 (100%)	0/24 (0%)	15/15 (100%)	0/15 (0%)
Eli	DDCI	32-42	41/44 (93%)	3/44 (7%)	49/49 (100%)	0/49 (0%)
Total			**(158/162) 98%**	**(4/162) 2%**	**(162/168) 96%**	**(6/168) 4%**

Every utterance that was included in the original raw data analysis, that is, any utterance with a verb and argument, is presented in Tables 4.8 and Table 4.9. This includes ASL-only utterances (from Tables 4.2 and Tables 4.3), blended utterances (from Table 4.5 and Table 4.6), and the combined totals for each word order investigated. Furthermore, both the 20-30 month stage and the extended 20-40 month period are listed separately. These nuanced totals provide a more comprehensive picture of the bimodal bilingual children's word orders involving sign language and allow us to compare the two time periods and the type of word orders produced by language mode. These tables differ from previous tables in that they are grouped by utterances containing a verb and object (Table 4.8) and utterances containing a subject and verb (Table 4.9).

A few patterns emerge when looking at all the raw data simultaneously. First and foremost, more noncanonical word orders are present in the extended time period of 20-40

months. This is our first indication that noncanonical word orders may be acquired a bit later than what has been reported for deaf children but there is not enough evidence at this point whether development is protracted or divergent. This is examined more closely in the first-repeated use analysis in Section 4.3. Also, variation among participants in terms of language mode becomes clearer. For example, Ben is more balanced in his use of ASL-only and blended utterances while Wiz more strongly prefers blended utterances to ASL-only utterances. In Chapter 5, the effect of language mode preference on the production of noncanonical word orders is examined. Overall, the percentage of noncanonical word orders produced by the bimodal bilingual children remains relatively low, even with ASL-only and blended utterances combined. Thus the bimodal bilingual children's use of noncanonical word order still diverges significantly from that of the deaf children in Chen Pichler (2001).

Table 4.8: Verb and object word order patterns for ASL-only, blended and combined

			Verb + Object					Verb + Object			
Child	Status	Age	canonical VO		noncanonical OV		Age	canonical VO		noncanonical OV	
Ben	Koda	20-30 months	ASL-only	Blended	ASL-only	Blended	20-40 months	ASL-only	Blended	ASL-only	Blended
			(18/18) 100%	(5/5) 100%	(0/18) 0%	(0/5) 0%		(45/46) 98%	(49/49) 100%	(1/46) 2%	(0/49) 0%
			Combined		Combined			Combined		Combined	
			(23/23) 100%		(0/23) 0%			(94/95) 99%		(1/95) 1%	
Wiz	Koda	20-30 months	ASL-only	Blended	ASL-only	Blended	20-40 months	ASL-only	Blended	ASL-only	Blended
			(1/1) 100%	(3/3) 100%	(0/1) 0%	(0/3) 0%		(2/2) 100%	(44/45) 98%	(0/2) 0%	(1/45) 2%
			Combined		Combined			Combined		Combined	
			(4/4) 100%		(0/4) 0%			(46/47) 98%		(1/47) 2%	
Eli	DDCI	20-30 months	ASL-only	Blended	ASL-only	Blended	20-40 months	ASL-only	Blended	ASL-only	Blended
			-	-	-	-		(13/13) 100%	(41/44) 93%	(0/13) 0%	(3/44) 7%
			Combined		Combined			Combined		Combined	
			-		-			(54/57) 95%		(3/57) 5%	
Jem	DDCI	20-30 months	ASL-only	Blended	ASL-only	Blended	20-40 months	ASL-only	Blended	ASL-only	Blended
			(4/4) 100%	(11/11) 100%	(0/4) 0%	(0/11) 0%		(11/11) 100%	(24/24) 100%	(0/11) 0%	(0/24) 0%
			Combined		Combined			Combined		Combined	
			(15/15) 100%		(0/15) 100%			(35/35) 100%		(0/35) 0%	

Table 4.9: Subject and verb word order patterns for ASL-only, blended and combined

			Subject + Verb					Subject + Verb			
Child	Status	Age	canonical SV		noncanonical VS		Age	canonical SV		noncanonical VS	
Ben	Koda	20-30 months	ASL-only	Blended	ASL-only	Blended	20-40 months	ASL-only	Blended	ASL-only	Blended
			(18/18) 100%	(8/8) 100%	(0/18) 0%	(0/8) 0%		(66/71) 93%	(61/62) 98%	(5/71) 7%	(1/62) 2%
			Combined		Combined			Combined		Combined	
			(26/26) 100%		(0/26) 100%			(127/133) 95%		(6/133) 5%	
Wiz	Koda	20-30 months	ASL-only	Blended	ASL-only	Blended	20-40 months	ASL-only	Blended	ASL-only	Blended
			(0/1) 0%	(2/3) 67%	(1/1) 100%	(1/3) 33%		(2/4) 50%	(37/42) 88%	(2/4) 50%	(5/42) 12%
			Combined		Combined			Combined		Combined	
			(2/4) 50%		(2/4) 50%			(39/46) 85%		(7/46) 15%	
Eli	DDCI	20-30 months	ASL-only	Blended	ASL-only	Blended	32-42 months	ASL-only	Blended	ASL-only	Blended
			-	-	-	-		13/14 93%	(49/49) 100%	(1/14) 7%	(0/49) 0%
			Combined		Combined			Combined		Combined	
			-		-			(62/63) 98%		(1/63) 2%	
Jem	DDCI	19-30 months	ASL-only	Blended	ASL-only	Blended	19-34 months	ASL-only	Blended	ASL-only	Blended
			(5/5) 100%	(8/8) 100%	(0/5) 100%	(0/8) 100%		(17/17) 100%	(15/15) 100%	(0/17) 0%	(0/15) 100%
			Combined		Combined			Combined		Combined	
			(13/13) 100%		(0/13) 0%			(32/32) 100%		(0/0) 0%	

The previous analysis suggests that in order to adequately compare the word order productions of bimodal bilinguals we should include all utterances that include signing. Thus, ASL-only and blended utterances were combined in Tables 4.8 and 4.9. Another potential issue is ensuring that productivity is justly comparable across groups. The body of literature on vocabulary development suggests that when counting bilingual vocabulary it is important to count vocabulary from both of the child's languages (Bialystok 2001, Hoff et al 2011). Studies have shown that when researchers count vocabulary from only one of the bilingual's languages it will not be comparable, in terms of productivity, to the monolingual norm. Not to mention, more recent larger-scale studies have indicated that bilingual children have smaller English vocabularies than age-matched monolingual children (Bialystok & Feng 2011, Bialystok et al. 2010, Marchman et al. 2010, Vagh, Pan & Mancilla-Martinez 2009, Thordardottir, Rothenberg, Rivard & Naves, 2006). Therefore, we may expect differences in terms of productivity between monolinguals and bilinguals. Heeding this suggestion from research on vocabulary development, considering the utterances in all of the language modes with signing is further justified. While it is beyond the scope of this dissertation to analyze the word order of the bimodal bilingual children's English-only utterances, extending the data to include partially and fully blended utterances provides a more accurate picture of their word order production. When the number of utterances produced is represented graphically it is evident that in order to have comparable rates of multi-sign utterances we should focus the analysis on the extended 20-40 month paradigm. When the total number of utterances, both ASL-only and blended, are compared to the deaf children in Chen Pichler (2001) when we match the ages across groups (20-30 months), the bimodal bilinguals fall short (Figures 4.1 and 4.2). However, when we extended the data an additional 10 months, the total number of utterances produced rivals the deaf children. Therefore,

in order to control for productivity, the 20-40 month period will be the focus on subsequent analyses.

Figure 4.1: Age-matched comparison verb-object order

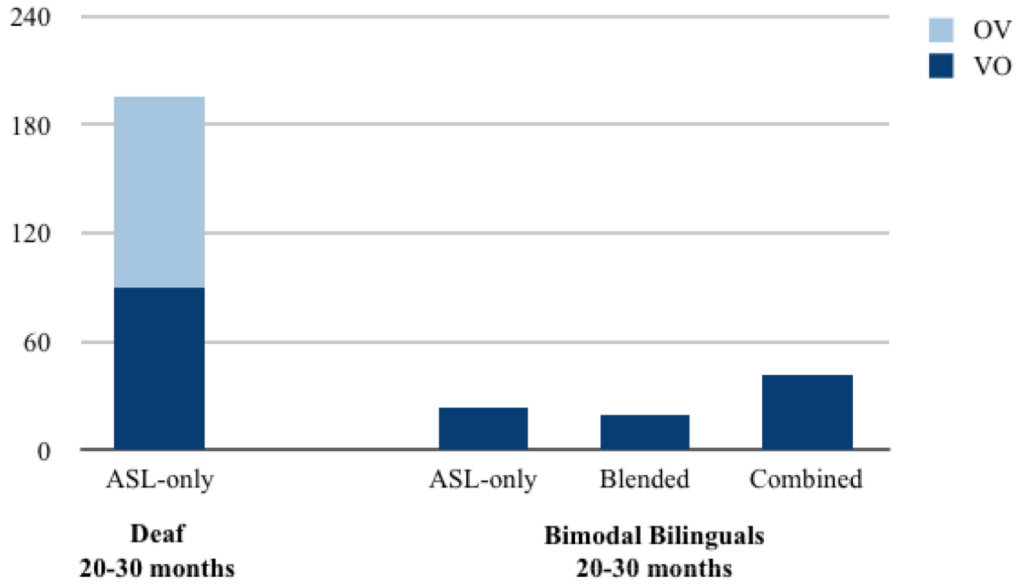


Figure 4.2: Age-matched comparison subject-verb order

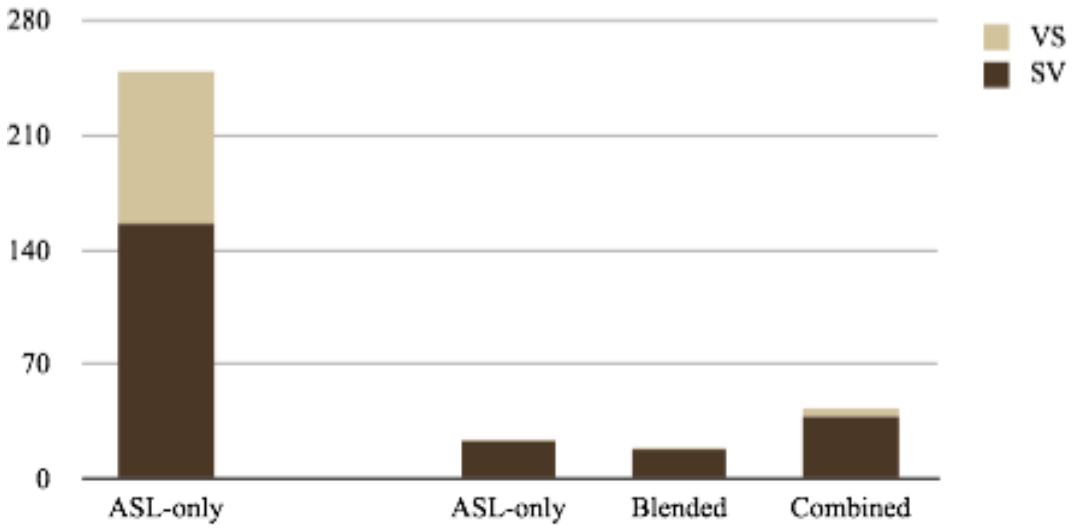


Figure 4.3: Extended sample comparison verb-object order

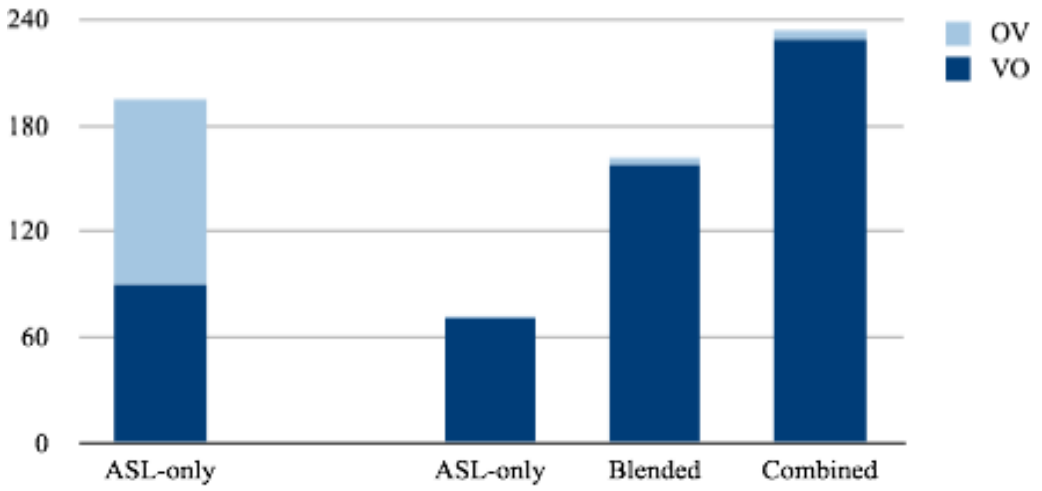
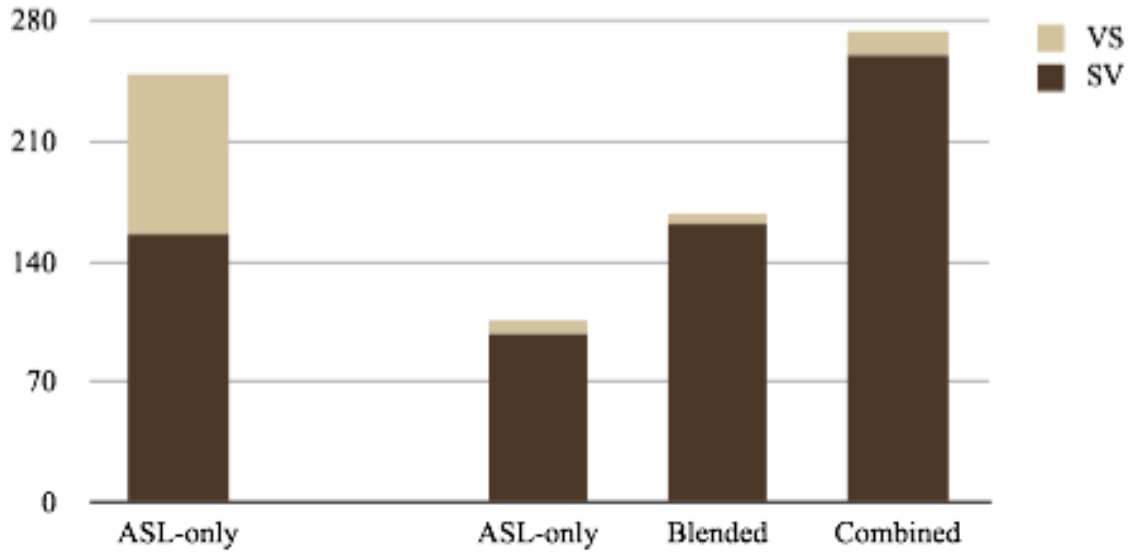


Figure 4.4: Extended sample comparison subject-verb order



In summary, these first results demonstrate that the bimodal bilingual children produce far fewer noncanonical word orders compared to the deaf children in Chen Pichler (2001) and

are not nearly as productive overall with two-sign combinations with a verb and at least one argument between 20 and 30 months. However, this difference disappears when the time period investigated is extended by 10 months. The best we can conclude from measures of sign productivity is that it is slightly protracted with bimodal bilinguals and that is it important to include blended utterances for syntactic analyses. Turning to word order, a similar pattern emerged. The rate of noncanonical word order production was relatively low between 20 and 30 months. While this pattern remains constant across the different time periods investigated (i.e., early 20-30 months and extended 20-40 months) and despite language mode (i.e., ASL-only, blended-only, both ASL and blended combined), the use of noncanonical word orders does increase between 30 and 40 months. Although the productivity of two-sign utterances appears to be protracted, the number of noncanonicals produced, even after extending the data 10 months, remains relatively low. This suggests that in terms of noncanonical word order acquisition, the bimodal bilingual diverge from deaf controls. The following sections will assess the developmental trajectory of various ASL word order types by bimodal bilinguals and identify the first-repeated use for each word order type. In line with what was established earlier, the subsequent analyses examine the total number of utterances (both ASL-only and blended utterances) during the extended time period 20-40 months henceforth.

4.3 Developmental Trajectory

Since there is evidence to suggest the bimodal bilingual children are developing differently than deaf children the next question that must be answered is whether the children are increasing their production of both canonical and noncanonical utterances over time. This removes the focus from the overall low occurrence of noncanonical orders and instead tries to identify a developmental trend in productivity, however small. That is, it is feasible that the

bimodal bilingual children are simply exhibiting control of features associated with noncanonical word orders at a much slower rate than their deaf counterparts, but that they eventually reach the same endpoint. Insufficient evidence of delayed development could lead to an interpretation that the bimodal bilingual children's acquisition patterns are more divergent than they are protracted.

The graphs in Figure 4.5 and Figure 4.6 clearly show that both groups are developing canonical word orders (SV and VO) over time. From 20 to 40 months, it is apparent that the bimodal bilingual children, like the deaf children from 20 to 30 months, are increasing the number of two-word combinations steadily. Turning to Figures 4.7 and 4.8, this pattern holds true for the deaf children with noncanonical word orders: over time the deaf children use more and more VS and OV utterances. However, this is not the case for the bimodal bilinguals. The trend line for VS utterances (Figure 4.7) remains flat for the time period studied, indicating that VS orders are occurring infrequently and are not increasing with time. There is a slight positive trend line for OV utterances (Figure 4.8) but they occur rarely and do not appear until after 30 months of age.

Figure 4.5: Gradual development of canonical subject-verb word order for both deaf and bimodal bilingual signers

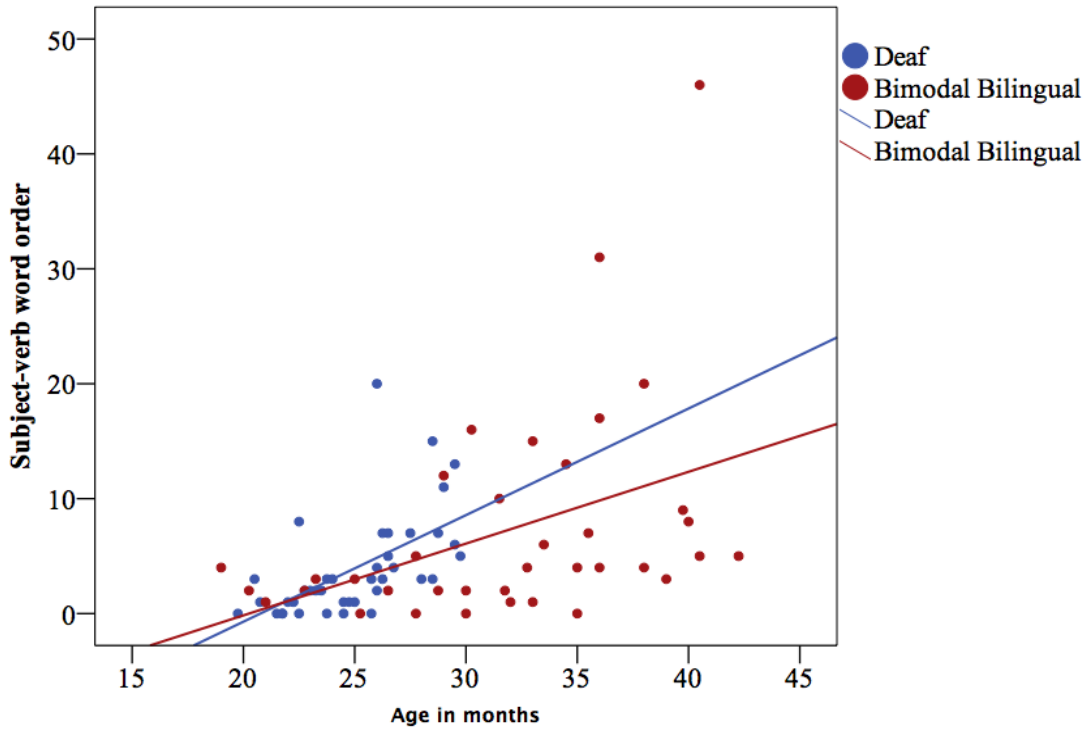


Figure 4.6: Gradual development of canonical verb-object word order for both deaf and bimodal bilingual signers

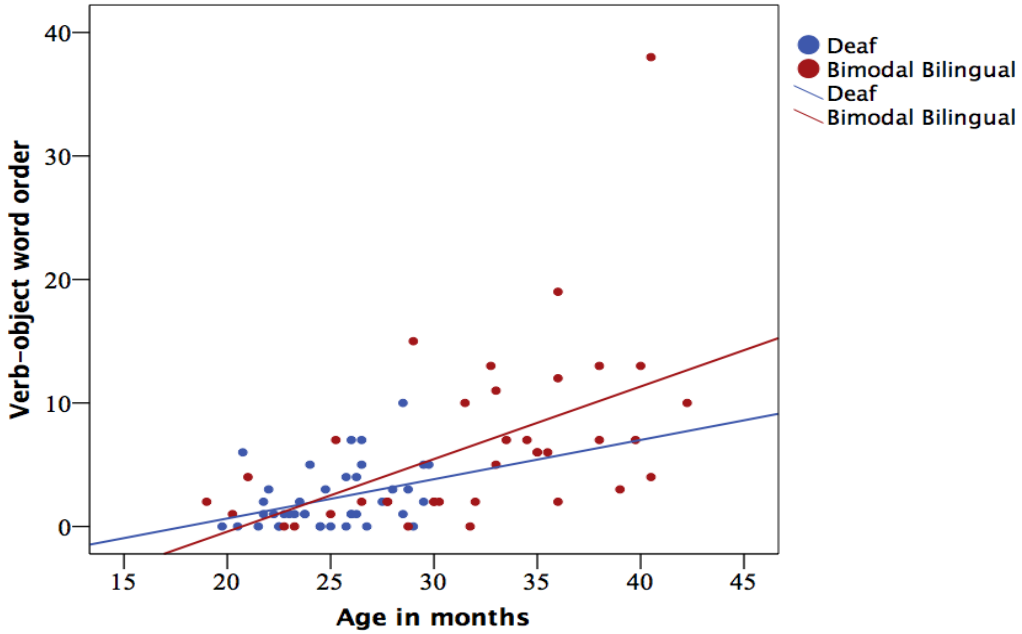


Figure 4.7: Development of noncanonical verb-subject word order for deaf signers but not bimodal bilingual signers

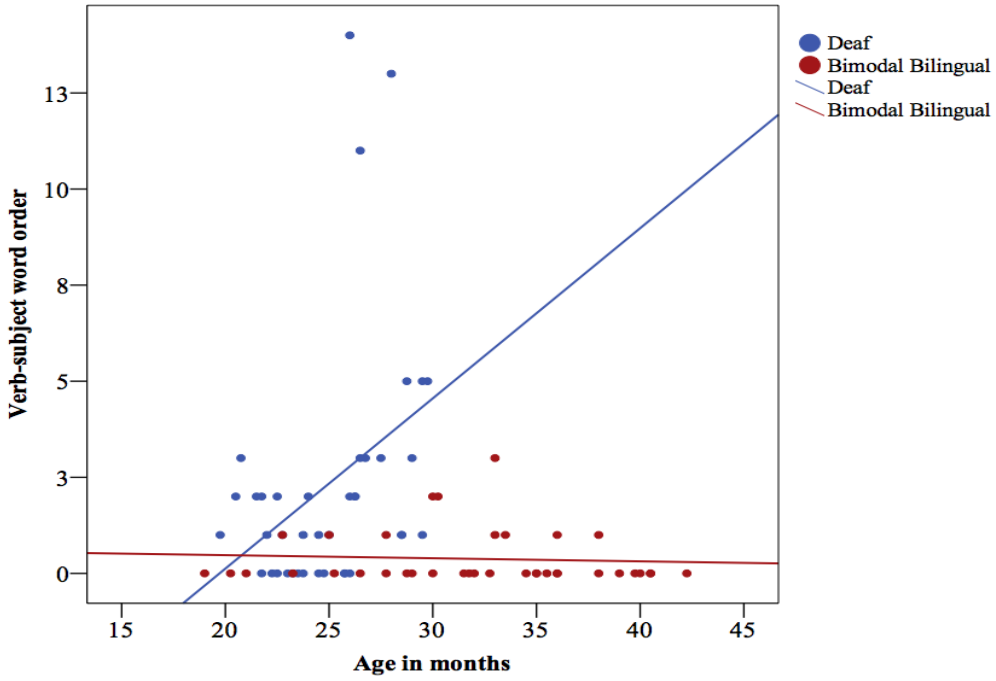
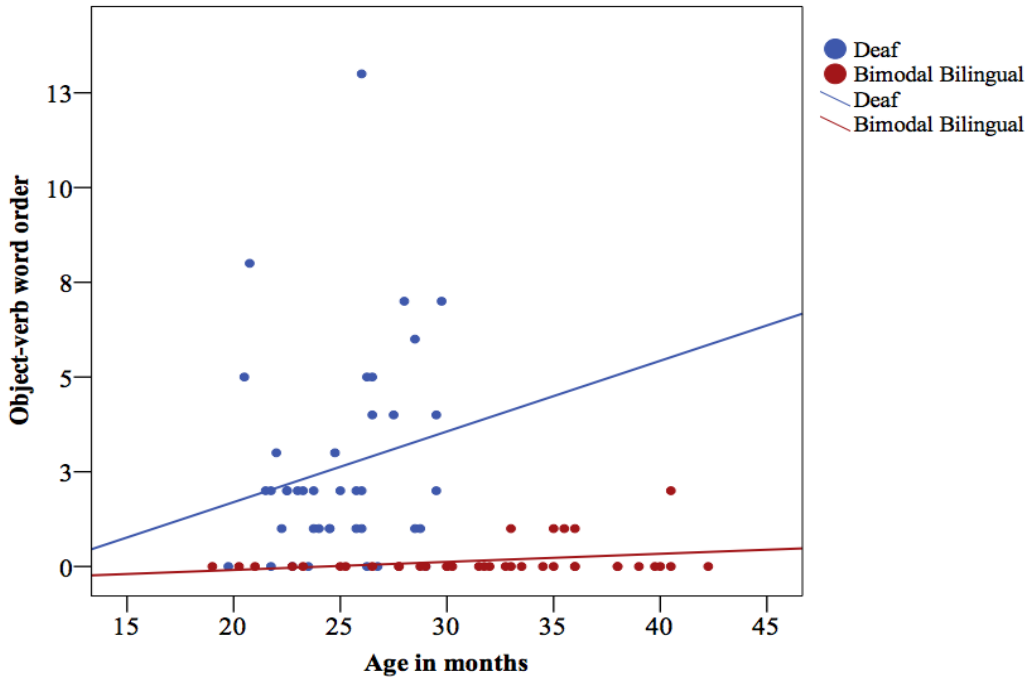


Figure 4.8: Development of noncanonical object-verb word order for deaf signers but not bimodal bilingual signers



These results from Section 4.1 indicate that the bimodal bilinguals are producing far fewer noncanonical utterances overall than the deaf children. Although it was still possible that the data could reveal a protracted developmental trend, plotting the word order instances over time failed to yield a clear developmental trend for noncanonical utterances. Yet, given the limited span of time studied and lack of literature on bimodal bilingual word order, it is a bit premature to make assumptions about the acquisition of noncanonical word orders by bimodal bilinguals. To clarify some of the emerging trends seen thus far, three statistical analyses are conducted to provide a more robust analysis of the differences between the deaf children from Chen Picher (2001) and the bimodal bilingual children in this study. As discussed earlier, since the time period studied or language mode did not yield any differences for the bimodal bilingual children, the statistical analysis will include the extended time period (20-40 months) and the number of utterances per session will consist of the ASL-only and blended combined. By doing this, the total number of utterances compared across groups is comparable. Following the presentation of statistics, we turn to a measure of age of acquisition, first-repeated use, developed by Stromswold (1996) as yet another attempt to try and understand the development of variable word order in ASL by bimodal bilinguals.

For the first statistic analysis (Table 4.10 and Table 4.11), a mixed effects linear regression was used with number of utterances produced, age, and hearing status as fixed effects, and participant name as a random effect. For the bimodal bilinguals, the number of utterances produced includes both ASL-only and blended utterances. This test confirms that as the children get older they produce more utterances ($\beta = 0.453$; s.e. = 0.064, $t = 7.102$). This merely indicates that the children (both deaf and bimodal

bilingual) are developing over time and can be considered typically developing. In terms of word order effects, there are significantly fewer OV utterances produced than VO (β = -2.870; s.e. = 0.720, t = -3.984) and significantly fewer VS utterances produced than SV (β = -4.130; s.e. = 0.720, t = -5.733). However, this apparent pattern of children producing significantly more canonical utterances than noncanonical utterances warrants further scrutiny. We can see which group is driving this effect through subsequent two-way analysis. One group difference that can be gleaned from this analysis, supporting our earlier observations, is that the deaf children overall still produce significantly more utterances than the bimodal bilinguals (β = 2.786; s.e. = 1.273, t = 2.188).

Table 4.10: The effect of hearing status and age on the number of utterances produced. The base levels for comparison are bimodal bilingual for hearing status and VO for word order.

Random variables and slopes	Variance	SE	Correlation
Participant name (intercept)	2.227	1.491	
Residual	19.978	4.470	
Base Variables	β	SE	t value
Intercept	-10.009	2.275	-4.400
WordOrderSV	1.208	0.720	1.677
WordOrderVS	-2.922	0.720	-4.056
Variables of Interest			
WordOrderOV	**-2.870**	**0.720**	**-3.984**
Age	**0.453**	**0.064**	**7.102**
HearingStatus(Deaf)	**2.786**	**1.273**	**2.188**

Table 4.11: The effect of hearing status and age on the number of utterances produced. The base levels for comparison are bimodal bilingual for hearing status and SV for word order.

Random variables and slopes	Variance	SE	Correlation
Participant name (intercept)	2.227	1.491	
Residual	19.978	4.470	
Base Variables	β	SE	t value
Intercept	-8.801	2.275	-3.869
WordOrderVO	-1.208	0.720	-1.677
WordOrderOV	-4.078	0.720	-5.661
Variables of Interest			
WordOrderVS	**-4.130**	**0.720**	**-5.733**
Age	**0.453**	**0.064**	**7.102**
HearingStatus(Deaf)	**2.786**	**1.273**	**2.188**

In the second statistical analysis (Tables 4.12 and Table 4.13), a two-way mixed effect linear regression was conducted that examined the effect of word order type and hearing status on the number of utterances produced. There was a significant interaction between word order type and hearing status ($\beta = 8.372$; s.e. = 2.210, $t = -3.789$). Namely, the deaf children from Chen Pichler (2001) produced significantly more OV utterances to VO utterances ($\beta = -6.405$; s.e. = 0.975, $t = -6.571$) and more VS utterances to SV utterances ($\beta = -6.892$; s.e. = 0.975, $t = -7.070$) than the bimodal bilingual children. This confirms early observations that the percentage of noncanonical word orders produced by bimodal bilinguals is lower than that by the deaf children.

Table 4.12: Two-way interaction: the effect of word order type and hearing status on the number of utterances produced. The base levels for comparison are VO and bimodal bilingual.

Random variables and slopes	Variance	SE	Correlation
Participant name (intercept)	2.335	1.528	
Residual	17.577	4.193	
Base Variables	β	SE	t value
Intercept	8.372	2.210	-3.789
WordOrder OV	-6.405	0.975	-6.571
WordOrder SV	0.703	0.975	0.721
WordOrder VS	6.189	0.975	-6.350
Age	0.459	0.060	7.618
WordOrderSV:HearingStatusDeaf	0.972	1.352	0.719
WordOrderVS:HearingStatusDeaf	6.289	1.352	4.65
Variable of Interest			
WordOrderOV:HearingStatusDeaf	**6.805**	**1.352**	**5.032**

Table 4.13: Two-way interaction: the effect of word order type and hearing status on the number of utterances produced. The base levels for comparison are SV and bimodal bilingual.

Random variables and slopes	Variance	SE	Correlation
Participant name (intercept)	2.335	1.528	
Residual	17.577	4.193	
Base Variables	β	SE	t value
Intercept	-7.60	2.20956	-3.471
WordOrder VO	-0.703	0.975	-0.721
WordOrder OV	-7.108	0.975	-7.292
WordOrder VS	-6.892	0.975	-7.070
Age	0.459	0.060	7.618
HearingStatusDeaf	0.301	1.518	0.198
WordOrderOV:HearingStatusDeaf	-0.972	1.352	-0.719
WordOrderSV:HearingStatusDeaf	5.833	1.352	4.313
Variable of Interest			
WordOrderVS:HearingStatusDeaf	**65.317**	**1.352**	**3.932**

The third statistical analysis conducted was a two-way mixed effects linear regression without a base comparison variable (Tables 4.14, Table 4.15, Table 4.16 and Table 14.17). The comparison variable in previous analyses allowed us to look at the relationship between a particular word order with any other that was specifically designated. For this second set of two-way interactions, the effect of hearing status and age on each of the word orders (i.e., SV, VS, VO, and OV) was conducted. This set of statistical tests examines how each word order progressed over time across groups and answers the question: Do the groups differ significantly in the number of utterances produced over time for each word order independently? The tests confirm that for canonical word order production over time there is no difference between groups (SV: $\beta = 0.271$; s.e. = 0.440, t = 0.616; VO: $\beta = -0.272$; s.e. = 0.313, t = -0.868). This confirms early observations that the bimodal bilingual children develop canonical word orders on par with the deaf children from Chen Picher (2001). The series of tests additionally confirms that for noncanonical word order production over time there is a difference between groups ($\beta = 0.616$; s.e. = 0.157, t = 3.917; OV: $\beta = 0567$; s.e. = 0.125, t = 4.526). This indicates that the bimodal bilinguals are not developing use of noncanonical word orders similarly to deaf children. In addition to the relatively low frequency of noncanonical word orders observed earlier, the developmental growth curve greatly differs from the deaf children in Chen Pichler (2001).

Table 4.14: Two-way interaction: the effect of age and hearing status on the number of SV utterances produced.

Random variables and slopes	Variance	SE	Correlation
Participant name (intercept)	7.555	2.279	
Residual	3.805	5.814	
Base Variables	β	SE	t value
Intercept			
Age	-19.447	5.934	-3.277
HearingStatusDeaf	-3.667	11.765	-0.312
Variable of Interest			
Age:HearingStatusDeaf	**0.271**	**0.440**	**0.616**

Table 4.15: Two-way interaction: the effect of age and hearing status on the number of VO utterances produced.

Random variables and slopes	Variance	SE	Correlation
Participant name (intercept)	2.211	1.487	
Residual	18.671	4.321	
Base Variables	β	SE	t value
Intercept	15.661	4.227	-3.705
Age	0.689	0.127	5.416
HearingStatusDeaf	0.480	8.341	0.897
Variable of Interest			
Age:HearingStatusDeaf	**-0.272**	**0.313**	**-0.868**

Table 4.16: Two-way interaction: the effect of age and hearing status on the number of VS utterances produced.

Random variables and slopes	Variance	SE	Correlation
Participant name (intercept)	1.150	1.072	
Residual	4.218	2.054	
Base Variables	β	SE	t value
Intercept	0.895	2.126	0.421
Age	-0.016	0.063	-0.254
HearingStatusDeaf	13.351	4.219	-3.165
Variable of Interest			
Age:HearingStatusDeaf	**0.616**	**0.157**	**3.917**

Table 4.17: Two-way interaction: the effect of age and hearing status on the number of OV utterances produced.

Random variables and slopes	Variance	SE	Correlation
Participant name (intercept)	2.564	1.601	
Residual	2.328	1.526	
Base Variables	β	SE	t value
Intercept	-0.411	1.785	-0.230
Age	0.018	0.048	0.374
HearingStatusDeaf	-11.277	3.479	-3.241
Variable of Interest			
Age:HearingStatusDeaf	**0.567**	**0.125**	**4.526**

To summarize the findings thus far, it was first observed between 20 and 30 months that the bimodal bilingual children are producing fewer two-sign utterances than their deaf counterparts regardless of language mode (i.e., ASL-only, blended or combined). However, when the time period investigated is extended by 10 months, bimodal bilingual productivity is comparable to that of the deaf children, as long as we include both ASL-only and blended utterances. Looking specifically at the types of word

orders produced by the bimodal bilingual group, a much smaller percentage of noncanonical orders are present compared to the production of the deaf control group. This holds true even if the analysis of the bimodal bilingual group is extended to 40 months and regardless of language mode. Based on these early observations of raw tokens and percentages, one may be tempted to conclude that the grammar for noncanonical VS and OV word orders in ASL has yet to be acquired by the bimodal bilingual group. To supplement these observations, statistical analyses conclude that the bimodal bilinguals significantly differ from the deaf children in Chen Pichler (2001) on several fronts: they produce far few utterances overall, the proportion of SV to VS and OV to OV is much smaller, and, the growth curve for noncanonical word order greatly differs from the deaf children. With the statistical analyses supporting all of the raw percentage observations, it is clear that the bimodal bilingual children's word order performance deviates from what was reported for deaf children in Chen Pichler (2001). The question remains whether these measures of performance provide us any insight into the language competence of the bimodal bilingual children studied. Chomsky (1965) clearly delineates language competence and language performance: performance being defined as the actual use of language in any given setting while competence is defined as the individual's knowledge of the language. In the subsequent subsection, a measure of mastery, arguably one attempt at capturing competence, is applied to the data collected.

4.4 Age of Acquisition

As discussed earlier, Stromswold (1996) defines mastery of any particular structure according to the percentage of time a child uses the structure in obligatory contexts (Stromswold 1996). This type of criterion is difficult to apply to noncanonical

word orders in ASL because linguists are generally unclear about what which verb types or pragmatic contexts constitute obligatory contexts for OV and VS order. Stromswold (1996: 45) offers an alternative measure for acquisition that does not require identification of obligatory contexts. This alternative methodology involves three measures: (i) age of first use, (ii) age of repeated use, defined by the age at which a construction has been used twice in one month or five times over time, and (iii) the age of regular use defined by visual inspection of graphically represented occurrences. The first two measures will be applied to the data from deaf children published in Chen Pichler (2001) and to the data gathered in this study. The third measure, which is less clearly defined than the other two measures, will not be considered. However, the figures presented in the developmental trajectory section (Section 4.2) can be compared with the results presented below, perhaps satisfying the third measure as well.

Both the deaf children and bimodal bilingual children reach the first-use and repeated-use measure for canonical word orders, VO and SV, at an average of 23 months of age as shown in Tables 4.18 and 4.19. In Table 4.19, Eli is greyed out because we do not have any data for him before 32 months so he was excluded from the average calculation. Based on these two measures, it appears that on average, deaf and bimodal bilingual children acquire ASL canonical word order from the onset of two-word combinations and at the same age.

Table 4.18: Canonical word order age of acquisition for the deaf children (Chen Pichler 2001)

		Age of First Use	Repeated Use	Age of First Use	Repeated Use
Child	Status	verb > object		subject > verb	
NED	Deaf	26	26	25	26
SAL	Deaf	21	21	21	21
JIL	Deaf	22	22	22	22
ABY	Deaf	22	22	23	23
Average		**23**	**23**	**23**	**23**

Table 4.19: Canonical word order age of acquisition for the bimodal bilingual children

		Age of First Use	Repeated Use	Age of First Use	Repeated Use
Child	Status	verb > object		subject > verb	
Ben	Koda	20	21	20	20
Wiz	Koda	28	28	30	30
Jem	DDCI	19	19	19	19
Eli	DDCI	32	32	32	34
Average		**22**	**23**	**23**	**23**

For noncanonical word order the two participant groups diverge in terms of age of acquisition. For both OV and VS word order the deaf children reach the first-use and repeated-use measure on average at 23 months, as they did for noncanonical orders. This

analysis supports Chen Pichler's (2001) observations that deaf children do not exhibit a period of fixed word order, due to the fact that acquisition of both canonical and noncanonical word orders in ASL emerge very closely together.

Table 4.20: Noncanonical word order age of acquisition for the deaf children (Chen Pichler 2001)

		Age of First Use	Repeated Use	Age of First Use	Repeated Use
Child	Status	object > verb		verb > subject	
NED	Deaf	25	25	25	26
SAL	Deaf	21	21	20	21
JIL	Deaf	22	22	22	24
ABY	Deaf	23	23	19	21
Average		**23**	**23**	**22**	**23**

Table 4.21: Noncanonical word order age of acquisition for the bimodal bilingual children

		Age of First Use	Repeated Use	Age of First Use	Repeated Use
Child	Status	object > verb		verb > subject	
Ben	Koda	33	-	23	33
Wiz	Koda	35	-	28	38
Jem	DDCI	-	-	-	-
Eli	DDCI	36	-	34	-
Average		**35**	**>40**	**28**	**26**

However for the bimodal bilinguals, acquisition of noncanonical word orders cannot be confirmed for the period under observation using the Stromswold (1996) measures, as indicated in Table 4.21. Jem does not use any noncanonical orders during the time period studied, while the other three participants (Ben, Wiz, and Eli) produce their first use of OV between the ages of 33 and 36 months. This is in stark contrast to the deaf children's early first-use between 21-25 months of age. Moreover, none of the bimodal bilingual participants meet the twice-in-one-month criterion or produce at least five OV utterances to satisfy the repeated-use criterion. As for VS order, the bimodal bilinguals' first use comes in between 23 and 34 months (M = 28, SD = 5.51) closer to the range seen with the deaf children at 19-25 months (M = 21.5, SD = 2.65). Ben falls within the deaf children's range while Wiz falls within one standard deviation of the latest deaf child, Ned. Eli, however, exhibits a much later first use when compared to both Ben, Wiz and the deaf children. Ben and Wiz are the only two children to satisfy the repeated-use measure but they do so approximately 10-15 months later than the average for deaf children.

The Stromswold (1996) criteria for determining the age of acquisition, that is the actual mastery of a particular construction or structure, provides more insight into bimodal bilingual ASL word order development. Based on measures she proposed, it is clear that the bimodal bilingual children acquire canonical (SV and VO) word order in ASL from the onset of two-word utterances, around 23 months, as do the deaf children. It has also been confirmed that deaf children acquire the reordering operations required for noncanonical word orders in ASL at the same age. However, this is not the case for the bimodal bilingual children. Thus far, we have seen relatively low percentages of

noncanonical orders and a much slower developmental trend for VS and OV utterances. In this section, we found that only some of the children had acquired VS order and none of the children had yet acquired OV order within the time period investigated. Considering the different analyses employed hitherto, we conclude that the bimodal bilingual children are developing mastery of noncanonical orders like the deaf children but along a very different acquisition path.

4.5 Conclusion

In this chapter the results from analyzing the spontaneous longitudinal data of four bimodal bilingual children was presented. The basic word order analysis followed criteria set by Chen Pichler (2001) in order to faithfully compare the deaf of deaf children's word order patterns in her dissertation to the patterns exhibited by the bimodal bilinguals in the current study. Initial analysis of the children's ASL-only utterances was compared to the results in Chen Pichler (2001) for the exact same developmental period: 20-30 months. This apples-to-apples comparison suggested that the bimodal bilinguals are far less productive than the deaf children and noncanonical word orders were not present.

At this point, deviating from the methodology of Chen Pichler (2001), the time period investigated was extended by an additional 10 months and more noncanonical word orders began to emerge but productivity still remained glaringly different between the two groups. Next, the blended bimodal utterances were examined separately for both the 20-30 month period and the 20-40 month period. Noncanonical word orders did not appear to be more plentiful with blended utterances but the overall productivity started to be more commensurate with the deaf children's productivity. Once both the blended and

ASL-only utterances were considered for analysis, productivity became equivalent across groups. Various statistical analyses were conducted to determine if the bimodal bilingual children differed significantly from that of the deaf children reported in Chen Pichler (2001). The results indicated that the deaf children produce a significantly higher proportion of OV to VO utterances and VS to SV utterances. In addition, when considering the growth curve of the four word order types, bimodal bilingual children differed significantly from the deaf children in terms of noncanonical word orders (OV and VS) but not for canonical word orders (VO and SV). These patterns were confirmed using a measure of first-repeated use: the bimodal bilingual children acquire canonical word orders at the same time as deaf children (approximately 23 months) while they acquire noncanonical word orders 13 months later than the deaf children. The following chapter will examine some language internal and language external factors that may be driving the difference between the two groups.

CHAPTER 5 DISCUSSION

5.1 Introduction

This study examined the acquisition of ASL word order by bimodal bilingual children. In Chapter 4 the results of three analyses were presented in comparison with deaf controls from Chen Pichler (2001). The first analysis quantified the amount and proportion of each word order type on a child-by-child basis. The second analysis, a group comparison, examined the number of instances of each word order type over time. The third analysis used a first-repeated use measure to determine if the children had acquired canonical and noncanonical word orders during the time period studied.

For canonical word orders (SV and VO) the bimodal bilinguals performed on par with the deaf controls, in terms of when the word orders were acquired and how they developed over time. However, for noncanonical word orders (VS and OV) the bimodal bilingual children look strikingly different than the deaf monolingual controls on the number of noncanonical word orders produced, when the prerequisite reordering morphology was acquired, and how rapidly the development of noncanonical word occurred over time.

This chapter considers several internal and external factors that may account for/contribute to the observed divergence in noncanonical word order production between deaf and bimodal bilingual children. The language internal factors to be discussed include language synthesis and modality effects. Language external factors that will be examined are parental input and interlocutor sensitivity. An exploration of these factors is followed by a comparison between the word orders produced by bimodal bilingual children and deaf children with delayed exposure to sign language. This comparison assists in

situating the bimodal bilingual results in the broader context of children acquiring sign language and demonstrates that despite the divergence from the deaf controls, the outcome of native exposure to ASL, regardless of the pressures inherent with bilingualism, yields conservative production and far fewer errors than delayed exposure. This chapter concludes with a summary of the results based on the research questions that guided this study.

5.2 Internal Factors: Language Synthesis & Modality Effects

The Language Synthesis Model (Lillo-Martin et al. 2010, 2012, 2014; Koulidobrova 2012; Quadros et al., 2013), as described in Chapter 2, inherently allows for a considerable amount of language mixing. The combinatorial possibilities allowed by the architecture of the language faculty include phenomena such as transfer, code-switching, and code-blending. Since code-blending is unique to bimodal bilinguals, it is worth examining the possibility that modality exerts an effect on word order choice. In Section 4.5 it was demonstrated that noncanonical word orders were more likely to occur with sign-only or partially-blended utterances than in fully-blended utterances. Given that it has been extensively documented that bimodal bilinguals frequently code-blend (Emmorey et al. 2008, Lillo-Martin et al. 2014), it is reasonable to ask whether bimodal production, which entails phonation, discourages the production of word orders that cannot be easily mapped on to English counterparts.

In general, it has been observed that bimodal bilinguals favor synchronized, congruent production of sign and speech with respect to lexical content, syntax, and timing. Emmorey et al. (2008) found very few incongruent blends in their analysis of adult code-blending; on average 16% of blends were semantically incongruent. Emmorey

et al. (2003) categorized this incongruence into three categories: (i) conveying information about the same event but semantically non-equivalent, (ii) functioning similar to co-speech gestures whereas the sign precedes the semantically matched speech, and (iii) lexical retrieval errors. The propensity for code-blended signs and speech to be translation equivalents of each other may discourage the production of noncanonical word orders.

However, there is some cross-linguistic evidence that could potentially weaken this hypothesis. In a series of papers and presentations, Donati and Branchini (2010, 2013) have documented interesting word order phenomena occurring with the code-blends produced by young Italian bimodal bilinguals. As mentioned earlier, the basic word order of spoken Italian is SVO, while the basic word order Italian Sign Language (LIS: Lingua dei Segni Italiana) is SOV. This dissimilarity provides more opportunity than the English-ASL pairing for semantically incongruent blends reflecting two different word orders. Donati and Branchini (2013) provide examples from children who produce blends simultaneously adhering to the word order of each language, as illustrated below. While it appears that the architecture of the grammar allows for these unique blends, it should be noted they occur relatively infrequently and tend to be quite short, meaning they could potentially be memorized as a unit. For example, several examples provided by the authors include negation words and words that commonly occur with negation, like in (18).

(18) Incongruent blend

Eh? Non ho capito
uh? NEG have.1SG understand.PTCP
I UNDERSTAND NOT
'I don't understand.'

(Donati & Branchini 2013:10)

To date it is unknown how frequently these syntactic incongruent blends occur in adult bimodal bilingual production. When Donati and Branchini asked adults to reproduce the blends they found in the child data, it took several tries for the adult bimodal bilinguals to produce what appears to manifest naturally in the children's production. Given the rarity of these occurrences, and the fact that adults do not easily produce these incongruent word order blends, the generalization that bimodal bilinguals prefer to synchronize their signing and speech overall remains intact.

Returning to the current study, the data from English-ASL bilinguals do not support the spontaneous production of two divergent word orders simultaneously. Chen Pichler et al. (2014) reported a small number of incongruent blends in the longitudinal spontaneous data of four bimodal bilingual children, one of whom was Ben, a subject in the current study. However, the majority of those incongruent blends appeared to be timing errors, with children repeating a word in one modality until they achieved a lexically and temporally congruent blend. Presumably, processing for true incongruent code blend combinations would be quite taxing on the child, and this may be the main reason why incongruent blends do not occur with much frequency.

Further evidence that bimodal bilinguals prefer synchronization of sign and speech comes from a micro-analysis by Emmorey et al. (2008) of the onset of signs and speech in adult ASL-English code-blends found in their data. For the vast majority of

blended utterances (161/180 or 89.44%), the onset of the ASL signs were articulated simultaneously with the onset of the English words (Emmorey et al. 2008: 47). Chen Pichler et al. (2014) examined the content, timing, and syntax of one American child (Ben) and one Brazilian child (Igor) and their adult interlocutors. They found that the majority of blended utterances were coordinated, but the children mismatched more than the adults. They concluded that the coordination of speech and sign was still developing as evidence in the children's frequent repetitions and self-corrections.

When the children in this study produced bimodal noncanonical OV utterances, they adhered to the same word order in both English and ASL simultaneously. For example, Eli produces a noncanonical OV utterance in ASL and maintains the same word order in the English as seen in (18).

(19) Fully-blended utterance

DRUM, DRUM BRING
drum he brought me
O V
'He brought me a drum'

(Eli 3;06)

	
DRUM drum	BRING[spatial] drum he brought me

Chen Pichler et al. (2014) report one incongruent noncanonical word order blend in the data they analyzed. It was produced by Ben and occurred in an English-targeted session.

(20) Noncanonical word order in English

HOT CHOCOLATE IX(book) EAT IX(book)
chocolate eat
'He's easting (drinking) hot chocolate.'
(Ben 2;01)

Overall, these noncanonical utterances appear to be quite rare in the American bimodal bilinguals data. The timing of signing and speech simultaneously, the adherence to lexical congruity, and the relative absence of propositions with divergent syntax in blending collude in discouraging the production of noncanonical word orders. This appears to be a byproduct of the various constraints that have been documented thus far.

As mentioned in Chapter 2, there are several studies that have examined bimodal bilingual blending behavior and language differentiation. For any given interaction these children have the option of producing sign language only, spoken language only, or a combination of both. The overall consensus is that these children modify their relative proportion of language use based on the interlocutor (Petitto et al. 2001). For example, Ben was reported in Lillo-Martin et al. (2014) to use sign-only utterances in speech-targeted sessions with hearing interlocutors (who often also knew sign language) 5% of the time. However, in sign-targeted sessions that percentage increased to 45%. Ben's percentage of bimodal production, or blending, remained relatively constant at 37% for speech-targeted sessions and 43% for sign-targeted sessions. Although it is feasible for congenitally deaf children from deaf families to also produce bimodal utterances if they possess speaking abilities or perhaps some auditory access to English, this phenomenon

was not reported by Chen Pichler (2001) and did not comprise any significant proportion of the deaf children's utterances (D. Chen Pichler, personal communication, October 20th, 2015). Other studies report that bimodal bilingual children blend at a much greater rate than deaf children (van den Bogaerde 2000). Since this creates a fundamental difference in terms of language mode, it is feasible that the preference for one language mode over another has impact on the type of structures that bimodal bilingual employ and produce. This preference for a certain language mode over another will be referred to as the children's *synthesis tendency*. A fundamental question regarding the observance of various synthesis tendencies is whether or not it is more common to find noncanonical word orders with sign-only utterances than it is with blended utterances.

To consider this question, the utterances in the data set were coded for synthesis tendency. All utterances that were included in the word order analysis (criterion: verb plus at least one overt argument) were re-coded as ASL-only, fully blended, or partially blended. The following figures show the proportion of ASL-only utterances (ASL), in blue the fully blended utterances (FB) in orange, and the partially blended utterances (PB) in red. As explicated in Chapter 3, fully blended and partially blended utterances in previous studies are both considered blending, but for this analysis they are analyzed separately. Inspection of the canonical VO utterances in Figure 5.1 and SV in Figure 5.2, reveal the children's individual preferences by session. Solely based on the utterances included in this study's word order analysis, Ben's canonical utterances were predominantly ASL-only, Wiz's predominantly blended, and Jem's and Eli's fall somewhere in between.

Table 5.1: Synthesis tendencies with VO utterances

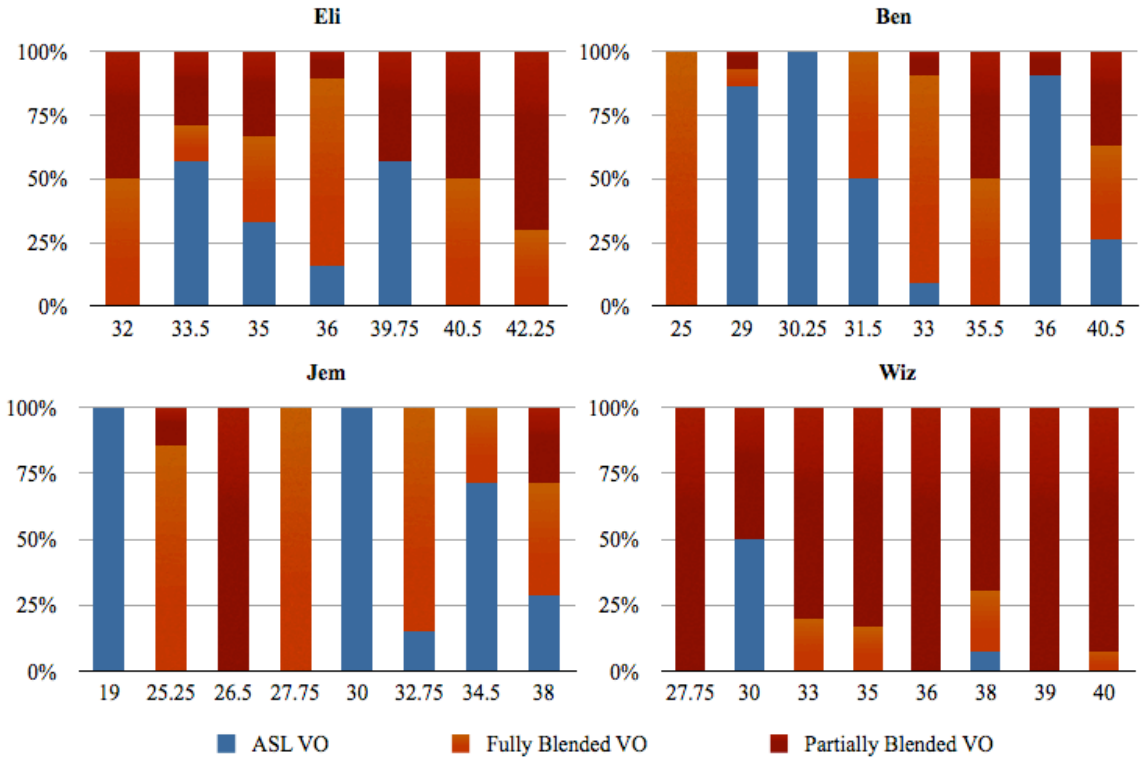
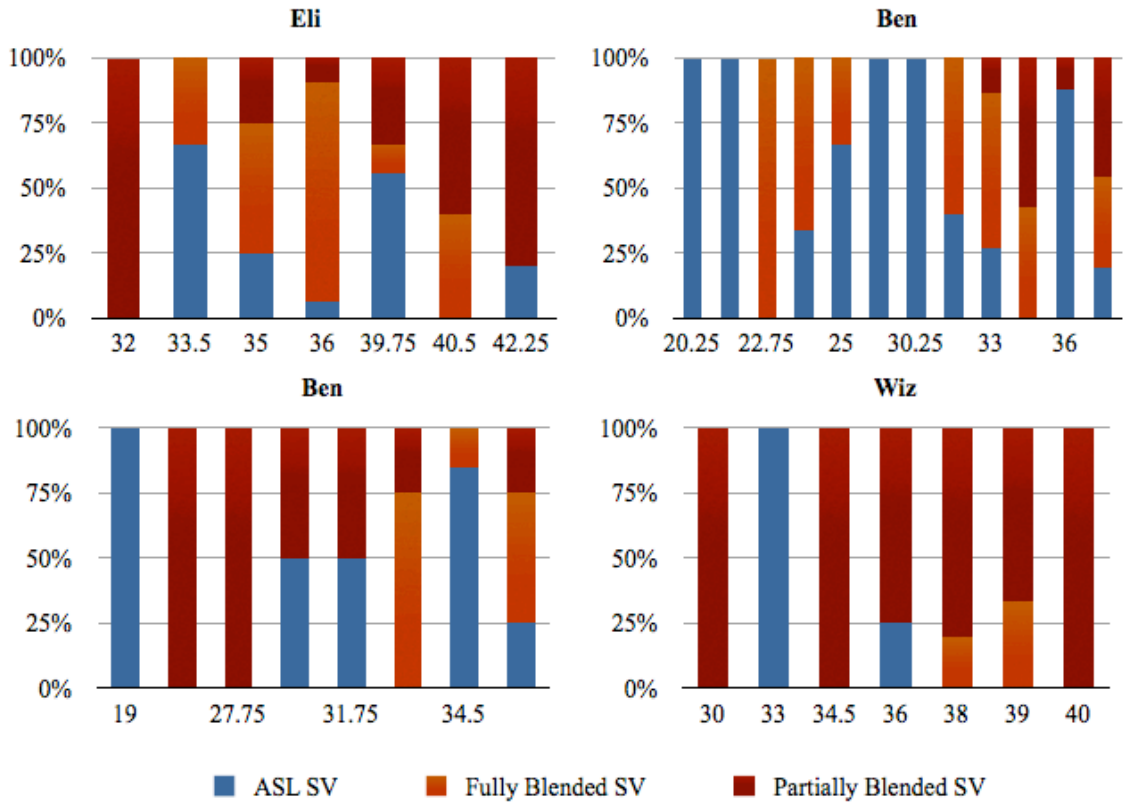


Table 5.2: Synthesis tendencies with SV utterances



Turning next to the synthesis tendencies with noncanonical word orders, in Figures 5.3 and 5.4 it is clear that the percentage of noncanonical ASL-only utterances for each child is higher than the percentage of canonical ASL-only utterances. Comparing Figures 5.1 and 5.2 with Figures 5.3 and 5.4, a higher percentage of noncanonical word orders in the ASL-only mode is evident. While noncanonical utterances appear with every language mode, the most occur with ASL-only utterances, followed by partially blended utterances and then lastly by fully blended utterances.

Table 5.3: Synthesis tendencies with OV utterances

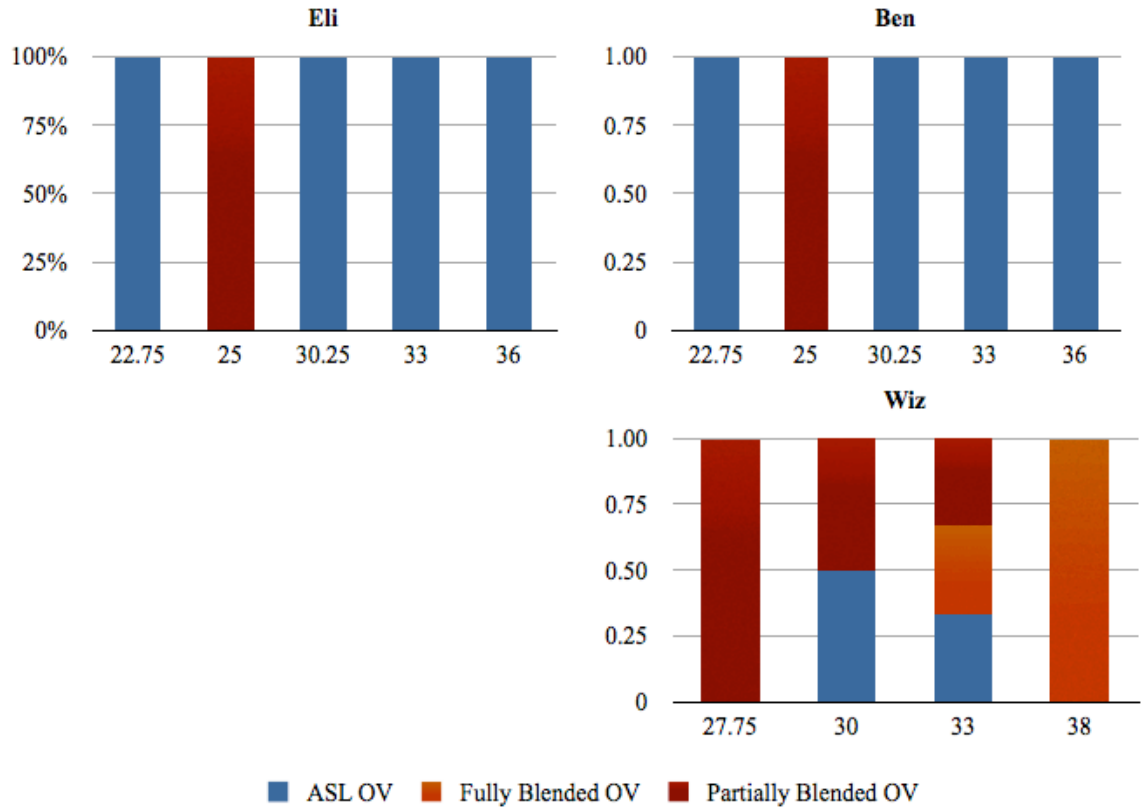
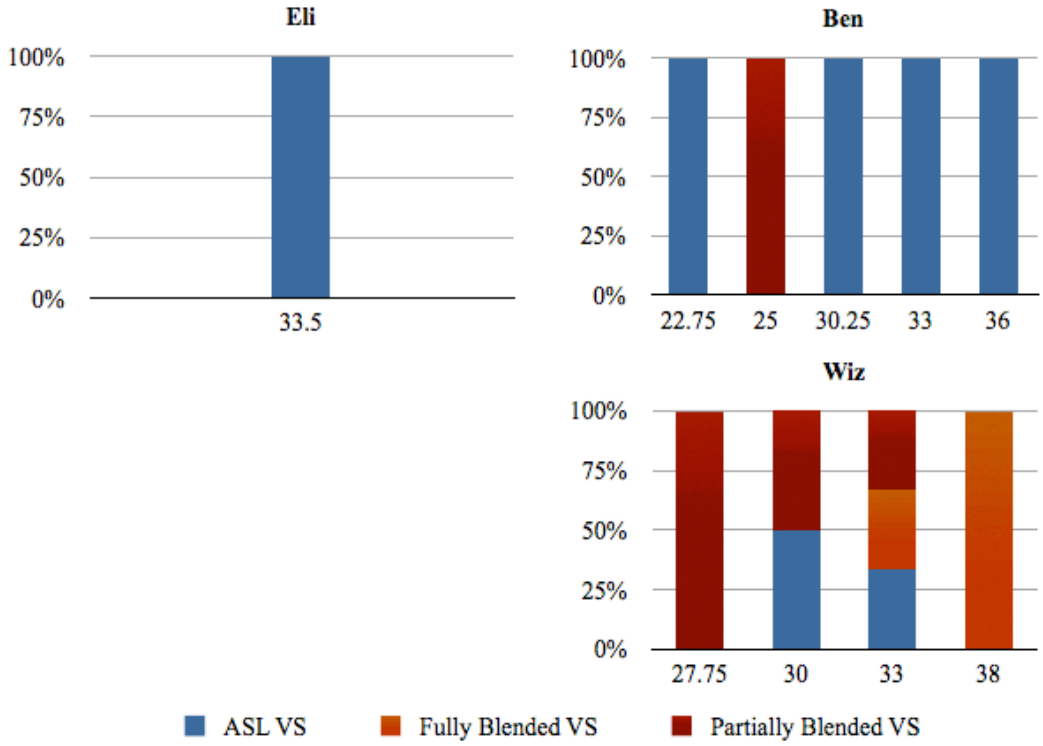


Table 5.4: Synthesis tendencies with VS utterances



In summary, although the bimodal bilingual children vary in the mode they favor for canonically ordered utterances, their noncanonical ordered utterances occur predominantly in ASL-only production. While earlier analyses seem to suggest that the bimodal bilingual children are avoiding noncanonical word orders, an examination of their synthesis tendencies reveals that code-blending might be at least partially responsible for the low number of noncanonical utterances. Importantly, there is evidence that noncanonical structures are part of the bimodal bilingual children's grammar. Although further research is needed to determine why noncanonical orders occur more frequently in ASL-only utterances than in blended utterances, some plausible factors

include the children being sensitive to that fact that phonation of ASL noncanonical word orders in English sounds strange in addition to the preference to time-align blended with congruent content.

5.3 Internal Factors: Language Dominance & Cross-Linguistic Influence

One possible explanation for the bimodal bilingual children's relatively low production of noncanonical word orders is to assume they are English dominant. Several studies have shown that bilinguals' weaker language is the one that differs from monolingual development. Language dominance could be used to argue why cross-linguistic transfer occurs from the dominant language to the weaker language. For example, Yip and Matthews (2007) found that cross-linguistic transfer due to language dominance could account for why their Cantonese-English bilinguals produced *wh*-in-situ questions when speaking English. However, not all structures are vulnerable to language dominance or input quantity. Paradis et al. (2007) studied French-English bilinguals and the French-dominant bilinguals scored lower on both English regular and irregular past tense compared to monolingual English children while the English-dominant bilinguals only scored lower on the irregular tenses. This suggests that some structures are affected by language dominance more than others.

In addition, sometimes the bilingual's production of a specific structure dwindles as the child grows older. This is yet another way language dominance can potentially account for a deficiency in the bilingual's weaker language. Mykhaylyk (2009) investigated the word orders produced by young Ukrainian-English bilingual children living in the United States. Both English and Ukrainian have canonical SVO word order, however in Ukrainian the direct object can occur pre-verbally (scrambled) with a

[+definite] interpretation. The 3-year-old monolinguals and bilinguals demonstrated similar scrambling rates, but by 6 years of age the bilinguals diverged significantly from the monolingual controls, leading the authors to conclude that the older children's end-state grammar differed due to increasing exposure to the dominant language, English, and subsequently led to the decline of their knowledge in the lesser-used language, Ukrainian. This supports other claims (e.g., Meisel 2007) that language dominance might have different weight at different developmental stages.

In this dissertation, there is no direct measure employed to quantify language dominance such as mean-length utterances (MLU). In general, comparing MLUs across languages can be problematic due to a lack of true translation equivalents across structures. This problem is only exacerbated by the fact that there is great debate within the field of sign language linguistics regarding the morphemic status of some elements (Lillo-Martin 2012b). However, a possible proxy measure for language dominance in the current study could be the sheer number of two-word utterances the children produce. The four deaf children studied by Chen Pichler (2001) produced 249 utterances with a subject and a verb. For the same time period (20-30 months), the bimodal bilingual children from this study produced only 24 utterances with two signs (ASL-only). This number increases to 43 utterances if blended utterances are included, but even then the bimodal bilingual children are only 17% as productive as the deaf controls. The overall low production of two-sign combinations could be taken as evidence that these bimodal bilinguals are English-dominant even at a very young age and this dominance could be one factor that affecting the children's production of noncanonical word orders.

In addition to issues related to input quantity and its relationship to the child's dominant language, some researchers have suggested that over-reliance on one particular word order over another could be based on reinforcement from the other language and/or economy principles. In accordance with Hulk and Müller (2000), English reinforces the SVO order option available in ASL. Furthermore, as suggested by previous researchers, English can be viewed as having a more restricted grammar than ASL with respect to word order, and therefore the children prefer it as the more economic one (Platzack 2001, Zuckerman 2001, Gavarro 2002, Westergaard & Bentzen 2007, Mykhaylyk 2009). These two factors, language dominance and structural overlap, seem to contribute to differences in word order production between the deaf children from Chen Pichler (2001) and the bimodal bilinguals studied here. Since it is quite difficult to disambiguate between these two factors, future research should include measures of language dominance so those effects can be teased apart from reinforcement possibilities.

5.4 External Factors: Role of Input

In this subsection the amount and type of word orders provided by the parents during child-directed signing is presented. This will help us determine whether or not the children are merely imitating their parents as this could account for the infrequent production of noncanonical word orders. Paradis and Genesee (1996) suggest bilinguals have their input space divided between the two languages they are acquiring. When compared to monolinguals, the frequency of exposure to either language is smaller at any given time point. In addition to reduced frequency, other factors such as cross-linguistic transfer, language mixing in the input, and sociolinguistic pressures like language

prestige can all conspire to propel the bilingual child on a developmental path that does not resemble a prototypical monolingual.

This analysis in this subsection aims to quantify the amount of noncanonical word orders that subjects are being exposed to by their parents. Rates of noncanonical order in the input are particularly important to investigate because the transmission of sign language to these children may differ from monolinguals and even other bilinguals. First, the majority of deaf signers are non-native users of the language. The latest statistic estimates that only 5% of deaf parents have deaf children (Mitchell & Karchmer 2004). Therefore, it is important to first determine if the input the children are receiving is relatively uniform across the families. Secondly, it is equally relevant to determine if these bimodal bilinguals are receiving similar input in terms of proportion of canonical and noncanonical word orders when compared with deaf children from deaf signing families. The literature to date provides conflicting accounts of what type of word orders signing children are exposed to by their parents. Newport and Meier (1985) report that deaf children are exposed to variable word order by their parents while Kantor (1982) and Spencer and Harris (2005) suggest that parents modify child-directed signing to avoid complex verb types and produce a more linearized word order by supplying redundant points to arguments. The assumption here is that a more linearized word order results in SVO, although the authors did not explicitly state this. These previous reports have all focused on the input deaf children are receiving from their deaf parents. It is unclear if American deaf parents provide a different type of input to their typically hearing children. However, van den Bogaerde (2000) reported that the Dutch deaf mothers in her study used their voice with their hearing bimodal bilingual children most of the time.

Select child-parent sessions were analyzed to examine the extent to which noncanonical word orders occurred in the input. The same criteria used for the bimodal bilingual children were applied to the analysis of the parental word order: only utterances that contained a verb and a least one overt argument were included. Table 5.5 presents the percentage of VO and OV utterances and the percentage of SV and VS utterances in the adult production for one session/child. These percentages are informative if we believe the children are analyzing the input in such a way that they are attending to, for example, the position of the object with respect to the verb. If the bimodal bilingual children are analyzing the input in this way, and the parental sample examined here is representative of the input, then children see instances of object-verb order anywhere from 3 to 15 percent of the time, and instances of verb-subject order 11 to 24 percent of the time.

Table 5.5: Percentages of verb + object and subject + verb utterances in a sample of child-directed signing by interlocutor

			Verb + Object		**Subject + Verb**	
Interlocutor	**Session**	**Duration**	**canonical VO**	**noncanonical OV**	**canonical SV**	**noncanonical VS**
Ben MOT	15	47 mins	40 (87%)	6 (13%)	40 (89%)	5 (11%)
Wiz MOT	27	39 mins	28 (85%)	5 (15%)	28 (78%)	8 (22%)
Jem & Eli FAT	57	31 mins	29 (97%)	1 (3%)	38 (76%)	12 (24%)

Despite the very small sample, only one session per parent, it is clear that the parents are using noncanonical word orders with their children. Both Ben and Wiz's mothers are patterning very closely in their production of OV word order (~14%) while Jem and Eli's father are producing far fewer (3%). On the other hand, we have Wiz's mother and Jem and Eli's father patterning similarly for VS word order (~23%) while Ben's mother is producing about half as many at 11%. Relevant to this analysis is the question of whether the children are matching the amount of noncanonical orders in the input. In addition, is there a certain necessary threshold that drives the use of noncanonical orders by the children? Based on the parental patterns presented, one could predict that Ben and Eli will pattern similarly in terms of OV production because they received similar rates of OV from their parents; while Jem, Eli and Wiz will pattern closely in terms of VS production because they received similar rates of VS from their parents. To test these predictions, the data from the children are paired with their respective parent in Table 5.6 and 5.7.

Table 5.6: Bimodal bilingual overall percentages of VO and OV

Child	Status	Age	VO	OV
Ben	Koda	20-40	94/95 (99%)	1/95 (1%)
Wiz	Koda	20-40	46/47 (98%)	1/47 (2%)
Jem	DDCI	20-34	35/35 (100%)	0/0 (0%)
Eli	DDCI	32-42	54/57 (95%)	3/35 (5%)

Table 5.7: Bimodal bilingual overall percentages of SV and VS

Child	Status	Age	SV	VS
Ben	Koda	20-40	127/133 (95%)	6/133 (5%)
Wiz	Koda	20-40	39/46 (85%)	7/46 (15%)
Jem	DDCI	20-34	32/32 (100%)	0/0 (0%)
Eli	DDCI	32-42	62/63 (98%)	1/63 (2%)

It is clear from the data presented in Tables 5.6 and 5.7 that these predictions do not bear true. Ben and Wiz do pattern similarly in terms of their infrequent use of OV word order but Eli, whom we predicted to pattern differently than the other children because his father produces far fewer OV word orders, actually produces the most out of any of the children and more than his father (Table 5.6). Turning to VS utterances (Table 5.7), it was predicted that Wiz, Jem and Eli would all produce more VS utterances than Ben. Wiz is the only child that produces a proportion of VS utterances (15%) that is closer to his mother (22%) and Jem and Eli's father (24%). However, it should be noted that although Ben does not produce the same proportion of VS utterances as his mother (5% versus 11%), his total number of utterances is very similar (6 versus 5). Notably, both Jem and Eli diverge from their father quite significantly in terms of VS production. They do not produce nearly the number or proportion of VS utterances they are receiving in the input despite the prediction that Wiz, Jem and Eli would look similar. Overall, it does not appear that children are closely tracking the word order of the input they are receiving. This could be a threshold issue. The deaf children in Chen Pichler (2001) produce far more noncanonical orders than either the bimodal bilinguals or the bimodal bilinguals'

parents. This may be because the deaf children's parents are supplying far more noncanonical utterances than the bilingual bimodal parents. Such a hypothesis can only be tested through analysis of the noncanonical utterances produced by the deaf children's parents, a topic for future study.

In summary, the results from this subsection suggest that the children are not merely imitating the percentage of word orders provided in their input and either a threshold issue is at play or a myriad of other factors are contributing to patterns described. Jem and Eli's father produces the highest number of VS utterances in the parent-child sessions analyzed yet the children produce the lowest number of VS out of the 4 bimodal bilingual children. Since the parents' word order choices do not seem to be directly affecting the children's production perhaps other interlocutors involved in the data collection process, many of the hearing, might be a factor in the divergence noted.

5.5 External Factors: Interlocutor Sensitivity

It has been suggested that bilingual children from a very young age can determine which of their two languages they should use with specific interlocutors. In general, bilingual children have been observed to use more of language A with an interlocutor who speaks A, and more of language B with an interlocutor who speaks B (Genesee et al. 1995, Petitto et al. 2001, Lillo-Martin et al. 2014). For the spontaneous longitudinal data used in this study, various interlocutors were experimenters as well as the cameraperson. To test whether the hearing status of the child's adult interlocutor was a factor in the child's word order choice, the hearing status of the experimenter or cameraperson was noted for each of the 43 sessions analyzed. The majority of experimenters were deaf but the majority of camerapersons were hearing signers (Table 5.7). A *t*-test was used to

determine if there was an effect on the use of a particular word order with either a deaf or hearing interlocutor (Table 5.8). For the effect of the cameraperson, there was no significant difference between the OV utterances produced in the presence of a deaf or hearing cameraperson ($t(41) = -0.78$, $p = 0.44$). In fact, more OV utterances were produced in the presence of a hearing cameraperson than a deaf cameraperson. Similarly, more VS utterances were produced in the presence of a hearing cameraperson but there was no significant effect of hearing status on the production of VS utterances overall ($t(42) = -1.21$, $p = 0.23$). As for the effect of the hearing status of the experimenter or parent, OV and VS utterances were produced more frequently when a deaf interlocutor was interacting with the child. However, this did not differ significantly when the experimenter was hearing for OV ($t(41) = -0.34$, $p = 0.74$) or VS ($t(41) = 0.77$ $p = 0.45$). While none of the statistic tests outlined in Table 5.8 reached significance, meaning that the presence of hearing interlocutors did not cause a difference in the word orders produced, it is reassuring to note two things. One, the presence of a hearing cameraperson did not reduce the number of noncanonical utterances, and two, even though the majority of noncanonical utterances appear in sessions with a deaf experimenter, the few sign-target sessions that occurred with a hearing experiment did not significantly skew the results with respect to word order.

Table 5.8: Percentage of hearing versus deaf interlocutors

Researcher Role	Deaf	Hearing
Cameraperson	17/43 (40%)	26/43 (60%)
Experimenter	33/43 (77%)	10/43 (23%)

Table 5.9: Interlocutor effect on word order

		OV	VS	t-test
Cameraperson	Deaf	20%	17%	$t(41) = -0.78$, $p = 0.44$ $t(42) = -1.21$, $p = 0.23$
	Hearing	80%	83%	
Experimenter	Deaf	60%	84%	$t(41) = -0.34$, $p = 0.74$ $t(41) = 0.77$ $p = 0.45$
	Hearing	40%	16%	

The results from this sub-analysis find only weak support for the possibility that bimodal bilingual children produce more noncanonical orders when interacting with deaf experimenters and no support for their word order being influenced by the hearing status of the cameraperson. Since the majority of sessions included in this study's dataset were not filmed with hearing interlocutors, in addition to being filmed without a parent present, the low production of both noncanonical OV and VS is not influenced by the interlocutor. These results do not negate the fact that these bimodal bilingual children are indeed sensitive to their interlocutors in terms of choosing which language to use. In Lillo-Martin et al. (2014) the children used more sign with deaf adults than they did with hearing interlocutors clearly making appropriate languages choices. However, they did use their voice more often in the sign-targeted sessions and they used signing in the speech-targeted sessions. This asymmetry suggests that the bimodal bilingual children are code-blending quite frequently and as stated in a previous section, this may be one reason why they are avoiding noncanonical orders in ASL.

5.6 Comparison With Delayed Exposure Deaf Signers

It is clear that the bimodal bilinguals in this study differ in terms of the number of word order variations they produce as compared with the deaf children in Chen Picher (2001). However, similarly to the deaf controls, the bimodal bilinguals produce very few noncanonical word orders that result in an ungrammatical sentence. For example, at 33 months old Wiz produces a verb-subject construction but does not use a pronoun (21). This is similar to errors made by both the deaf children in Chen Pichler (2001) and the delayed deaf children in Berk (2003). This is a fully blended utterance in which the child signs and speaks all the constituents in the sentence simultaneously. As mentioned earlier, verb-subject word order is permissible in ASL but only with pronouns as subjects.

(21) Ungrammatical verb-subject utterance by Wiz

FALL ROBOT
fell robot
V S
'The robot fell.'

(Wiz 3;02)

FALL
fell

ROBOT
robot

When we compare the bimodal bilingual children to deaf children that have had delayed sign language exposure (Berk 2003, Lillo-Martin & Berk 2003) we find some similarities as well as differences. First and foremost, both groups of children are not as productive in

their use of noncanonical word orders as are native deaf signers. This suggests that both the timing of exposure as well as the amount of input are important factors for acquiring the formal features that drive the derived word orders under discussion. However, quite significantly, bimodal bilinguals and late exposed deaf signers diverge in terms of amount of errors. According to the data collected by Berk (2003), the two delayed exposure deaf children studied produce ungrammatical object-verb sentences 42% of the time and ungrammatical verb-subject sentences 28% of the time. For bimodal bilinguals in this study, only 7% of the verb-subject utterances were ungrammatical. 75% of the OV utterances produced by the children were not of the reordering morphology type (i.e., spatial, handling, instrument or aspect). However, if we included other permissible object-verb orders in ASL such as topicalization, focus constructions, and idiosyncratic verbs such as HAVE and WANT the error rate drops drastically to 0%. When reviewing all the instances of canonical word order with a verb and an object the children use plain verbs and did not use verbs with reordering morphology that license preverbal objects (Appendix B) with the exception of the verb SEARCH. Each of the children used the verb SEARCH, which can occur with a preverbal object when inflected for aspect. However, the children used SEARCH, without aspectual morphology, therefore canonical VO order is grammatical in those cases. Also, in every context licensing a possible noncanonical word order (e.g. verbs with reordering morphology), noncanonical word order was consistently used.

Therefore, even though the delayed-exposed deaf children and bimodal bilingual children do not produce nearly as many noncanonical word orders as the typically developing deaf children their error rates are drastically different. It appears that the

bimodal bilinguals are overall conservative yet accurate. This suggests that they are acquiring the features associated with derived word orders in American Sign Language in a native-like fashion but perhaps at a much slower rate. Comparing children with delayed exposure to sign language to children who are bimodal bilingual from birth allows us to disambiguate the effects of bilingualism form the effects of delayed exposure. It is clear from the data presented in this section that delayed exposure to formal features can lead to a much higher rate of utterances that are ungrammatical, a phenomenon that is not present in the bimodal bilingual data. Nonetheless, the examination of error rates undertaken in this subsection do not offer any additional explanation as to why the bimodal bilingual children produce so few noncanonical word orders.

5.7 Bimodal Bilinguals As Heritage Signers

One way to account for the difference found in this dissertation between the deaf controls and bimodal bilinguals is to frame the bimodal bilinguals as heritage speakers (signers) of American Sign Language. In this section we will posit that given that ASL is the home minority language and English as the dominant language in school and in the broader social context that this creates a heritage situation in which the minority language is vulnerable (Reynolds & Palmer 2013, Reynolds et al. 2015). The results of this dissertation offer some of the first quantifiable evidence whereas we might expect very young children (i.e., around the age of 3 years old) to present similarly to monolingual counterparts when in actuality they do not. However, considering bimodal bilinguals as heritage signers of ASL is not without reservation. Linguists have often defined heritage speakers as having incomplete acquisition of the target grammar (Montrul 2002, Polinsky 1997 & 2006, Benmamoun et al. 2010). Rothman (2007) argues that heritage speaker

acquisition is not actually incomplete but that competence diverges from monolinguals because the heritage language context critically disrupts their acquisition process (i.e., their end-state grammar is best characterized as divergent rather than incomplete). Some scholars have even gone as far to posit that the grammar of heritage speakers should be treated as a new dialect/language (Pires 2012).

With the debate about how to define the competence of heritage speakers in mind, it is equally important to consider the fact that the subjects of this dissertation are children. These bimodal bilingual children have not yet reached their end-state grammars by age 3;04 and it may be premature to assume they will not continue to gain grammatical competence. Therefore, the definition of heritage signer here will make no claims regarding end-state grammar and instead will focus on i) the sociolinguistic context that is unique to the minority/majority language bilingual context, ii) the grammatical domains that are typically problematic for adult heritage speakers, and iii) the notion that early divergence from monolingual controls suggests the end-state grammar is, at a minimum, at risk of continuing to be divergent in early childhood and on into adulthood.

Research on spoken language heritage learners has revealed several trends regarding which grammatical domains are the most vulnerable. Phonology appears to be one area in which heritage speakers excel. Au et al. (2003) heritage language subjects demonstrated better production and perception than L2 subjects but still exhibited measurable differences from native controls. Lexical knowledge can be weaker than among native speakers with correlations between vocabulary proficiency and structural accuracy (Polinsky 1994, 2007). Morphology, and especially inflectional morphology, is

the most widely documented challenge for heritage speakers. The result is often reduced case and gender systems and difficulty with mood and aspect (Polinsky 2008, Montrul 2002 & 2007). Syntax is generally acquired but difficulties arise with complex structures and long-distance dependencies (Song et al. 1997, Kim et al. 2009, Polinsky 2008). For Mandarin-English heritage bilingual syntactic issues manifest themselves in terms of over-reliance on the basic SVO word order available in both language and difficulty with noncanonical word orders in Mandarin such as the object shifting *ba*-construction for spatial displacement and relative clause placement (Gallo et al. 2010). For the data presented in this dissertation, if we consider reordering morphology to be the main reason for OV utterances than we can expect to this be an impacted area for heritage signers.

The notion of ASL as a heritage language is not foreign to the many members of the deaf community. The community has long recognized the variable proficiencies of their hearing children and speculated as to why this may be the case. Deaf researchers, such as Dr. Stephen Nover from Gallaudet University, have seriously considered this issue and recently a series of papers and presentations are pushing the idea forward (Ashton et al. 2013, Reynolds & Palmer 2014, Compton 2014, Reynolds 2015). The *Standards for Learning American Sign Language* (Ashton et al. 2013) published by the American Sign Language Teachers Association (ASLTA) states:

> Heritage language learning is an emerging issue in ASL instruction. The formal instruction of ASL to deaf students is a very recent phenomenon, as is the availability of ASL instruction in K-12 settings for hearing children of Deaf parents. Heritage language learning is an important and developing interest in the field of ASL teaching and learning.
>
> (Ashton et al. 2013: 7)

As suggested by the ASLTA, Compton (2014) maintains that both deaf and hearing bimodal bilinguals are heritage language learners. Heritage learners are usually those who are actively taking language classes.

For our purposes here, we will be highlighting the heritage language context for bimodal bilinguals. Thus, they will be referred to as heritage speakers or signers henceforth. For hearing bimodal bilinguals their language learning is largely rooted in the community and at home. For deaf bimodal bilinguals, with the vast majority of them being born to hearing non-signing families, their ASL acquisition often takes place later once they have enter school. Compton's motivation for framing these bimodal bilinguals as heritage learners is to draw attention to the fact that most users of ASL are hearing or late acquirers of the language and issues of language maintenance should be considered. For the purposes of the forthcoming discussion, the focus will be not be on late acquiring deaf children even though their proficiency outcomes diverge from deaf children born into deaf families. This is because they do not learn sign language in the home and issues associated with language deprivation confound exposure and input issues that are crucial for identifying heritage learners. Instead, the discussion will narrowly include hearing bimodal bilinguals born to one or more deaf signing parents. In this section, a review of sociolinguistics factors that demonstrate hearing bimodal bilinguals are heritage signers will be followed by evidence from the literature on how these young signing children diverge from deaf children from deaf families during development and into adulthood.

For the past several years Peter Hauser and colleagues (Hauser et al. 2006, 2008) have been developing a testing instrument, the American Sign Language Sentence Reproduction Test (ASL-SRT), in an effort to standardize a measure of ASL proficiency.

The instrument has proved to effectively group signers together with similar language experiences (i.e., deaf native, hearing native, deaf early exposed, deaf late exposed, hearing L2).

Recently, Supalla et al. (2014) examined the ASL-SRT results from native signing participants with deaf parents more closely. The researchers grouped participants into three categories (deaf adults, deaf youth, and hearing adults) and analyzed the rate of correct sentence reproduction and the types of errors produced. While the analysis is intended to shed light on strategies regarding cognitive scaffolding, it also provides insights on how natively signing hearing bimodal bilinguals differ from natively signing deaf people. For the proportion of sentences produced correctly, Supalla et al. (2014) found that the two deaf groups did not differ, however, the hearing adults score significantly lower. This suggests that as a group, the native signing hearing adults exhibit a different proficiency level than the deaf adults and deaf youth. This is our first indication based on quantitative measures that even in adulthood hearing and deaf native signers perform differently on tests of ASL grammatical production. The hearing participants made significantly more lexical and morphology errors while there were no group differences for omissions or syntactic errors. These results align with previous work that suggests morphological is a problematic domain for heritage speakers. Further analysis conducted by Supalla et al. (2014) divided participants, regardless of hearing status, into three proficiency levels (high, moderate, and low) and a statistical test demonstrated significant fluency differences for each error type. In Table 5.9 it is evident that the vast majority (60%) of the hearing adults scored in the low fluency category.

Table 5.10: Number of participants per fluency category from Supalla et al. (2014)

Group	Low	Mod	High
Deaf adults	4	11	10
Deaf youth	6	6	13
Hearing Adults (Codas)	15	8	2

The error analysis from Supalla et al. (2014) offers some insight into the proficiency levels of adult bimodal bilinguals and the type of errors that are common. These results are the first clear quantitative evidence that adult bimodal bilingual ASL competence diverges from adult deaf of deaf. Over the past several years, research on child bimodal bilinguals has shown that at a very young age, when compared to deaf children from deaf signing families, the bimodal bilingual children are already showing some divergence. For example, it is clear from the work of Lillo-Martin et al. (2012) that bimodal bilingual children (ages 1;11 to 4;05) in both the United States and Brazil produce wh-phrases in all the permissible positions (initial, in-situ/final, and doubled). However, the children are heavily influenced by the positions that are permissible in their spoken language. The result, at least for the ASL-English bimodal bilinguals is that they produce far fewer in-situ/final and doubled wh-questions.

In summary, the sociolinguistic context in which these bimodal bilingual children are acquiring ASL as a minority language at home undoubtedly qualifies them as heritage signers. It has been widely reported that heritage speakers have difficulty with the

acquisition of complex morphology. In ASL, since reordering morphology is a primary source for noncanonical OV, the very low production of noncanonical OV orders by the bimodal bilingual children in this study may indicate that they have not acquired the requisite morphological feature(s) licensing those word orders.

5.8 Outcomes of Sub-Analyses

In this chapter, various internal and external factors were explored in an attempt to account for the bimodal bilingual children's overreliance on canonical word order and relative low production of noncanonical word orders when compared to deaf children. First and foremost it is apparent that the heritage language context predicts that certain morphological features are vulnerable to protracted or divergent acquisition. Inherent to the heritage context is the reduction in input quantity both as a result of bilingualism and the result of unequal prestige out in the wider community. In addition to an already tenuous situation due to external factors, internal factors are conspiring against the acquisition of word orders that are not present in both languages. Thus, the overlap of canonical SVO word order in both languages reinforces SV and VO as a viable option in ASL. In the current data, noncanonical word orders are more likely to appear in ASL-only and partially blended utterances than in fully blended utterances. This suggests that code-blending, the phonation of spoken words while signing, may have an inhibitory effect on the production of noncanonical words orders targeted in this study. The effects of code-blending on ASL production and the acquisition of grammatical features warrants further study.

5.9 Summary of Dissertation

The bimodal bilingual children examined in this dissertation all demonstrate control and complete acquisition of canonical word order just like the deaf children from Chen Pichler (2001) provided that both ASL-only and blended production are taken into account. All of the children exhibit first-use and repeated-use around 23 months. This suggests that similarly to deaf children, the bimodal bilingual children set their spec-head and head-complement parameters very early. As we expect with typically developing children, over time the number of utterances containing SV and VO gradually increases. Thus, the developmental trend lines for both groups look very similar for canonical word order. The only difference being that deaf controls consistently produced more tokens than bimodal bilingual children at each age. Even combining both sign-only and blended utterances, the bimodal bilingual children produce far fewer multi-sign utterances overall if we adhere to the 20-30 month time frame studied in Chen Pichler (2001).

Despite a lower frequency of occurrence, we can conclude for canonical word orders the bimodal bilinguals are developing typically. Moreover, when the bimodal bilingual data are extended an additional 10 months, the number of utterances produces becomes more comparable across the two groups of children and this kind of protracted development is frequently noted for a variety of aspects of bilingual grammar (e.g., mean length utterance (Meisel 2007, Schlyter & Håkansson 1994); development of finiteness (Blom 2010); differential object marking (Cuza et al. 2014); tense and aspect morphology (Silva-Corvalán 2014)).

In contrast, the bimodal bilinguals' development of noncanonical word orders is strikingly different from that of the deaf controls. Based on the first-repeated use

measure, the deaf controls acquire noncanonical word orders at 23 months, at the same time as canonical word orders and essentially from the onset of their first two-word combinations. The four deaf children in Chen Pichler pattern every closely and a chi-square test confirms that they are a homogenous group in regards to their proportion of VO to OV production ($\chi 2$ (3) = 4.83, p = 0.21) and their proportion of SV to VS production ($\chi 2$ (3) = 7.67, p = 0.053). Unlike the patterns seen with canonical word orders, the bimodal bilingual children are not very productive in their use of noncanonical orders. A chi-squared test confirms that they are homogenous in their proportions of VO to OV utterances over time ($\chi 2$ (3) = 3.02, p = 0.39), with all four children producing very few instances of OV. In a straightforward age-match comparison with the Chen Pichler (2001) deaf children, it appears the bimodal bilingual are in a temporary fixed word order stage while the deaf children do not exhibit such a pattern.

Extending the time period investigated by an additional 10 months, we see the bimodal bilinguals begin to produce OV utterances. There are infrequent uses, however, a development trend line is beginning to form. Perhaps if the time period studied were extended further we would eventually see the bimodal bilingual children producing noncanonical order frequently enough to indicate acquisition. Exploring the possibility that bimodal bilingual word order development observed here represents protracted development, Stromswold's acquisition measure was applied. The results showed that the bimodal bilinguals underperform their deaf counterparts through 40 months. While the deaf controls exhibit first-use at 23 months, the bimodal bilingual children average 35 months with the remaining five months not providing enough time to satisfy the repeated-use criterion. This is the case when considering all the OV utterances together when in

actuality the underlying operations that produce object-verb word order in ASL can probably be divided into a few subcategories. Nonetheless, the acquisition of noncanonical word orders appears particularly challenging for the bimodal bilingual children for the time period studied.

For noncanonical verb-subject order, the bimodal bilingual children do not perform as a homogenous group. This is evident from both the results of the chi-square test and the Stromswold age of acquisition measures. The chi-square test reached significance ($\chi 2$ (3) = 13.83, p = 0.003), which indicates that the participants differ significantly from one another in terms of their proportion of SV to VS proportions. The participants can be divided into two groups; the Kodas and the DDCI children. The Kodas, both Wiz and Ben, demonstrate first-use around 26 months and repeated-use around 36 months, with Wiz producing far more VS utterances than the other children. Yet despite a relatively early occurrence of first-use, Wiz and Ben do not achieve repeated-use for more than a year after the deaf controls. The deaf children from deaf families with cochlear implants (DDCI), Eli and Jem, produce a very low level of VS utterances. Jem does not produce any VS utterances. Eli, on the other hand, produces his first verb-subject utterance at 34 months and does not satisfy the repeated-use criterion by 42 months old. However, recall the earliest video for Eli is at 32 months. This means that nearly a year went by before the Stromswold measures could be applied which arguably makes such a comparison with the other children unfair. If we apply Stromswold's measures to Ben and Wiz starting at 32 months they achieve first-use and repeated-use by 33 months. Given that Jem does not produce any VS utterances and over a ten month span and Eli does not attain repeated-use, and given the fact that Ben and Eli are robust in

their production of VS throughout the time period study, it is prudent to conclude that the DDCI children and the Kodas are performing quite differently. To reiterate, this is the only clear difference between DDCIs and Kodas that has been noted throughout this entire study. For canonical word orders, SV and VO, as well as the production of noncanonical OV, all the bimodal bilingual children present fundamentally the same.

As has been noted, overall, the bimodal bilingual children acquire canonical word orders quickly and with ease at a very young age. On this front, the data give the impression that they are developing similarly to the deaf controls. Conversely, when compared to the deaf controls the bimodal bilingual children's production of noncanonical word order differs drastically.

5.10 Limitations and Future Work

There are inherent limitations with spontaneous data that should be noted. First and foremost, in the filming process many of our deaf research assistants commented on how it was difficult at times to get the children to willingly and comfortably converse in sign language. While this study did not employ any type of comparison between English and ASL there seem to be observable differences in the amount the children are producing in each language. The overall impression is that there are fewer sign language utterances than there are spoken language utterances. Often the children are busy playing with toys leaving the easiest modality for communication to be speech. While this holds true for all of the subjects in this study, it should be cautioned that determinations about the bimodal bilingual children's grammar would be best paired with comprehension tests, as well as elicitation tasks, for a more robust picture of their overall grammatical

competence. Future research would help illuminate the pervasiveness of some of the patterns identified in this study.

The nature of this data involved children acquiring two languages: one with a fixed word order and the other with a variable word order. While deaf children from deaf families seem to have no trouble acquiring the word orders studied in Chen Pichler (2001), the bimodal bilingual children appear to be retreating to the canonical word orders that are available in both English and ASL. Future studies could look at other language pairings that potentially could shed light on the patterns observed here. For example, what types of patterns emerge if the child is acquiring two variable word orders? One possibility is that the children acquire them with ease as because there is no consistent overlap that reinforces the canonical option. On the other hand, it is quite possible that in the face of overwhelming variation that the children still retreat to a fixed word order strategy. That is, the bilingual child might adopt, at least temporarily, a word order that is grammatical for both languages.

There is evidence from monolingual word order acquisition counter to what has been observed in Turkish (Slobin 1982, Ekmekçi 1986) and ASL (Chen Pichler 2001) that seems to suggest children do prefer a fixed word order during early multi-utterance development. Park (1970) observed his daughter using mostly canonical SOV order in Korean despite adequate input of the other word orders permissible in the language. Likewise, Gvozdez (1949, 1961) reported that his son initially preferred SOV while acquiring Russian and then later switched the canonical SVO word order. Perhaps one way to disambiguate these factors is to study two languages with variable word order. Ideally, both languages would have canonical SVO word order but differ in terms of their

noncanonical word order options. If one language had SOV for its noncanonical word order and the other had OSV for its noncanonical option it would be interesting to see if they children simply retreat to the canonical order that is permissible in both languages and/or if their development of one, or even both, of the noncanonical word orders is influenced by input quantity or some of the other factors outlined earlier.

5.11 Conclusion

The first research question guiding this study was: **Do the bimodal bilingual children produce the same amount and type of word orders as native-signing deaf children from deaf families?** The data presented in this dissertation clearly show that the bimodal bilingual children acquire canonical ASL word order on par with deaf comparisons, but produce far fewer noncanonical word. The remaining question is whether or not the patterns observed indicate a lack of order-changing operations in the children's grammars. Based on frequency alone, it is evident operations required for noncanonical VS and OV word orders in ASL are not yet very productive in the grammars of the bimodal bilingual children. Since frequency is not necessarily the most accurate measure of competency, it is important to look at various forms of evidence before making a firm conclusion. Starting with verb-subject order, the first-repeated use measure indicates that both of the hearing bimodal bilingual children acquired noncanonical VS order by the age of 36 months. This is much later than the deaf controls at 23 months but we have to keep in mind a few differences between the two datasets as outlined in the section above. The cochlear-implanted deaf bimodal bilingual children did meet the first-repeated use criterion for noncanonical VS order. However, filming Eli did not start until 32 months so it is quite possible that there would be further evidence in his

early productions not capture. Jem, on the other hand, was filmed at an early age but in general is a much more reserved child. There were several sessions where she did not produce very much signing and in general was very slow to warm up to various research assistants involved in the project. Other than these few factors there is not much evidence as to why this difference between the two bimodal bilingual groups was identified. We might have expected the cochlear-implanted bimodal bilinguals to perform more closely to the deaf children in Chen Pichler (2001) since they did not have any auditory access to English until after their first birthday. However, these children had been through intensive auditory training. This training might have highlighted canonical structures that overlap in English and in ASL. It would be interesting to compare the results found in this study with other cochlear-implanted deaf children from signing families that put less of an emphasis on speech and auditory training to test this hypothesis. As for VS word order development, the results suggest that the bimodal bilingual children are displaying overall protracted development.

Despite the differences between the two bimodal bilingual groups for noncanonical VS order, all of the bimodal bilingual children produce very few noncanonical object-verb word orders and did not meet the first-repeated use criterion. Thus, there seems to be insufficient evidence to conclude that the children have acquired the order-changing operations studied. However, there is evidence to suggest that the children are still actively acquiring the prerequisite features for noncanonical OV order. In two of the OV utterances produced by Eli he uses the appropriate morphologically complex verbs (e.g., BRING[spatial] and PUT-IN[handling]). The remaining OV utterances appear to be topics, focus constructions, or with the idiosyncratic verb types

(see Chen Pichler (2001) for verbs such as HAVE and WANT). Also, as mentioned earlier in this chapter, the bimodal bilingual children produce far fewer errors than late-exposed deaf children suggesting that despite overreliance on canonical word orders in their ASL production their acquisition path is still seemingly native-like. As for OV word order development, the results suggest that the bimodal bilingual children are displaying overall divergent development and there is scant evidence to suggest they will make significant gains in this domain.

In sum, based on the analyses of this study, it appears that the bimodal bilingual children have yet to acquire the order-changing operations for noncanonical word orders; this may be because they are heritage bilinguals and have yet acquire the morphological features licensing preverbal objects. Indeed, this study may offer the first quantifiable example of a specific grammatical area for which bimodal bilingual signers of ASL pattern similarly to other heritage speakers in terms underdeveloped morphology. It is unclear if they will eventually, later in life, produce more noncanonical utterances licensed by reordering morphology, or if this will remain a weaker component of their ASL grammar. Some aspects of grammar develop more slowly for bilingual children. However, this dissertation investigated the possibility of protracted development of noncanonical order by extending the period of observation by10 months. It was observed that production of noncanonical word orders still did not significantly increase. Thus, the data analyzed here are better characterized as illustrating divergent rather than protracted development for this domain.

The second research question guiding this study was: **What factors are influencing the bimodal bilinguals' word order production?** Based on several sub-

analyses it appears there are several factors that are conspiring to deter the features associated with noncanonical word orders in ASL. Theses include language mixing and the preference to code-blend over produce utterances in ASL only. This is confounded by both structural overlap between the languages and the fact that bimodal bilingual children might be displaying, despite being at such a young age, English dominance.

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APPENDICES

Appendix A: Jem's language assessment test scores

OWLS & Golden-Fristoe (Age 02;10)

Test	Standard Score	Description	Percentile	Age Equivalent
OWLS: Receptive	98	Average	45	03;00
One-Word Picture: Receptive	113	Average	81	02;09
OWLS: Expressive	96	Average	44	02;10
One-Word Picture: Receptive	113	Above Average	93	03;05
Golden-Fristoe 2: Articulation	95	Average	49	02;01

MacArthur-Bates CDI (Age 02;02)

Language	Word Understood	Words Produced	Phrases Understood
Spoken English	244/396	178/396	19/28
American Sign Language	290/396	132/396	21/28

Appendix B: Verbs used with canonical VO word order

Ben

DRIVE	COME	SAY	PET
SEE	READ	PICK/FIND	EAT
USE	LIKE	SEARCH	BITE
HEAR	PLAY	RIDE	GIVE-ME
WANT/DON'T-WANT	DRAW	FORGET	

Wiz

EAT	WANT	TAKE	BREAK
DRAW	LIKE	COOK	SAY
PLAY	WATCH	NEED	OPEN
SEE	MAKE	HELP	
WANT	OPEN	SEARCH	

Eli

GIVE	PUSH	PICK/FIND	LIKE
GET	SEARCH	MAKE	EAT
WANT/DON'T-WANT	THROW	BITE	TAKE
SAY	HAVE	SEE	HEAR
SHOOT	DRAW	PUT	

Jem

SEARCH	DRINK	WRAP	THROW
GET	DRAW	GO	
SPILL	RIDE	MAKE	
WANT/DON'T-WANT	DRIVE	READ	
EAT	HAVE	LIKE	

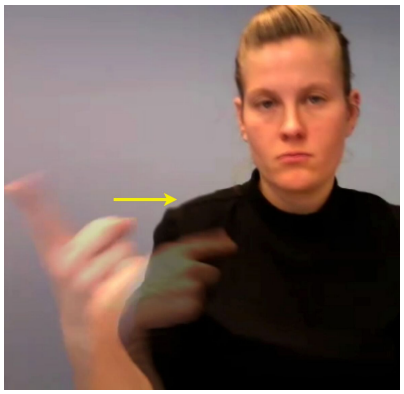
Appendix C: Noncanonical word orders in the dataset

Session	Age (in months)	ASL Utterance English Utterance	Mode	Word Order	Analysis
Eli_003	33.5	HURT IX(self)	ASL-only	VS	SPC
Eli_009	42.25	DRUM BRING drum he brought me	Full Blend	OV	spatial
Eli_019	42.25	MONEY DROP-IN-SLOT	Partial Blend	OV	handling
Ben_019	22.75	DV(legs-hopping) RABBIT	ASL-only	VS	error?
Ben_045	30.25	BREAK CAR	ASL-only	VS	
Ben_045	30.25	LOOK BREAK IX(book)	ASL-only	VS	SPC
Ben_045	30.25	TRAIN DV(wheels-moving) IX(train)	ASL-only	VS	SPC
Ben_061	33	SEE IX(self)	ASL-only	VS	SPC
Ben_061	33	HEARING-AID HAVE	ASL-only	OV	focus
Ben_075	36	SIT IX(self)	ASL-only	VS	SPC
Ben_075	36	LOOK BREAK IX(book), BREAK	ASL-only	VS	SPC
Wiz_042	27.75	BREAK IX(ceiling) break	Partial Blend	VS	SPC
Wiz_050	24.5	EAT IX(self) eat me	Full Blend	VS	SPC
Wiz_052	33	DV(flap-wings) BIRD flying bird	Full Blend	VS	error?
Wiz_052	33	FART farted I farted	Partial Blend	VS	SPC
Wiz_052	33	MONSTER monster draw monster	Partial Blend	OV	focus
Wiz_052	33	FALL ROBOT fell robot	Full Blend	VS	error?

Appendix D: Gloss index for canonical verb types (source: ID Gloss Project Fanghella et al. 2012)

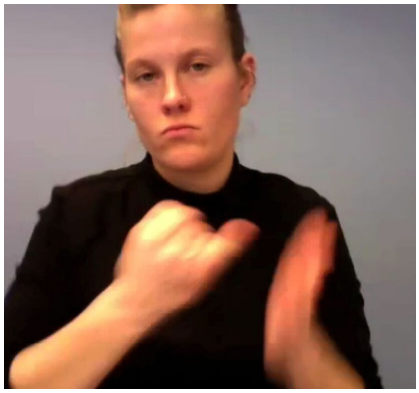
BITE

BREAK



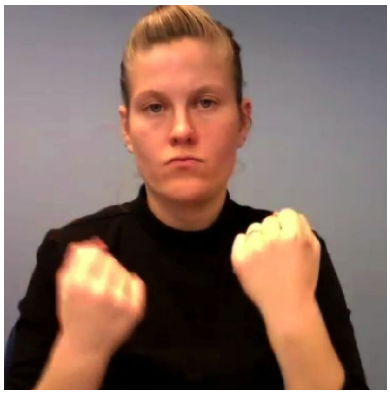
COME

COOK

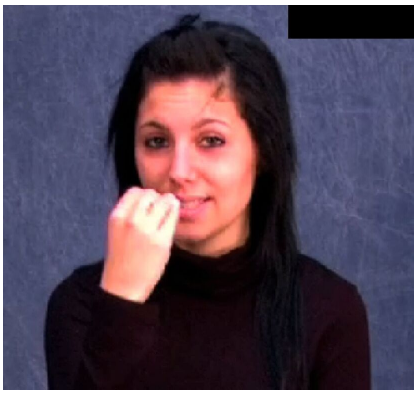


DRAW

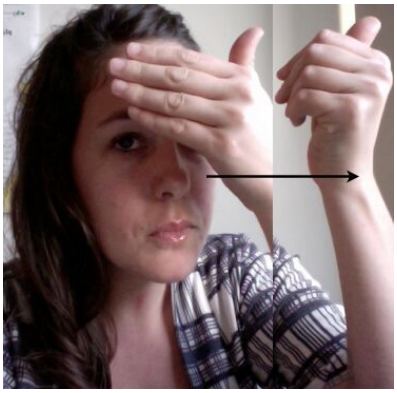
DRINK



DRIVE

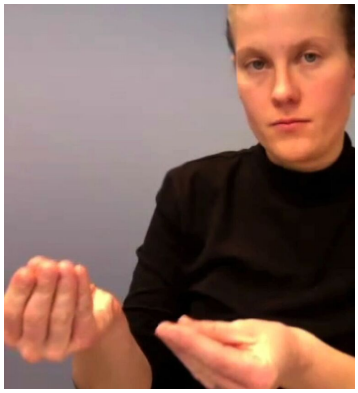


EAT

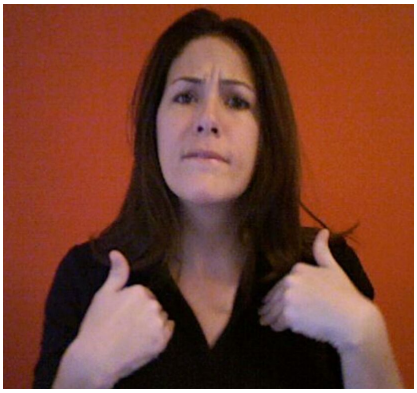


FORGET

GET

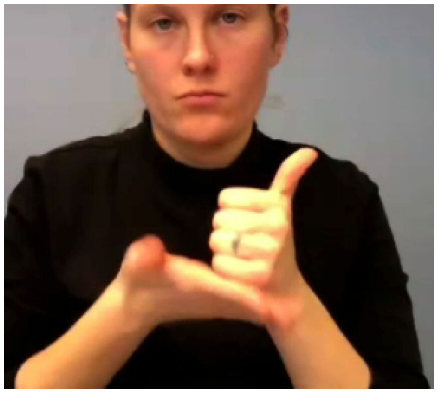


GIVE

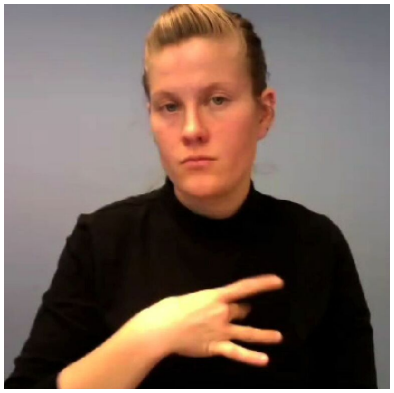


HAVE

HEAR



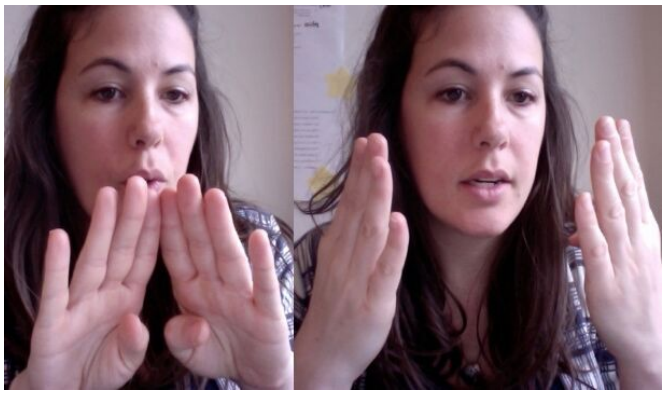
HELP



LIKE

MAKE

NEED



OPEN

PET

PICK/FIND

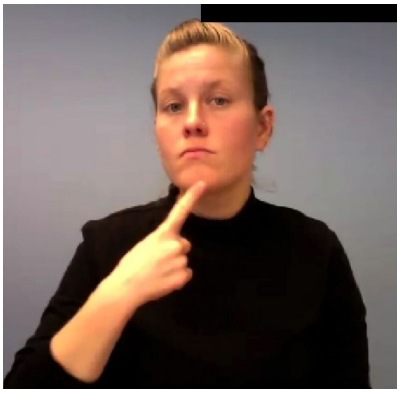
PLAY

PUSH

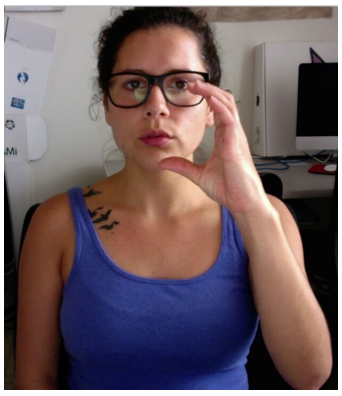
PUT

READ

RIDE



SAY

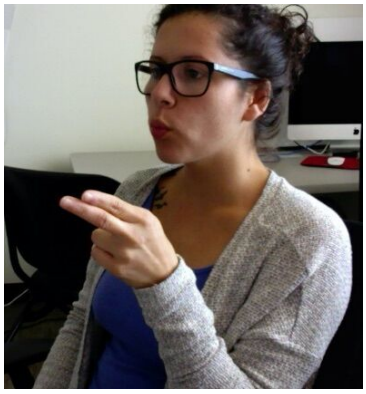


SEARCH

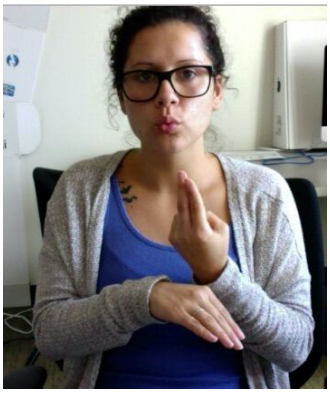
SEE

SHOOT

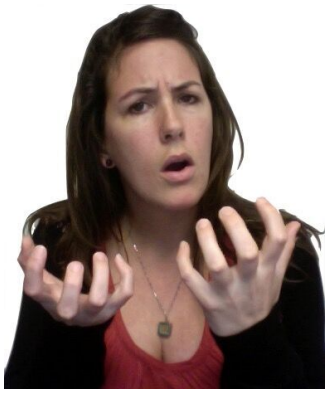
TAKE



THROW

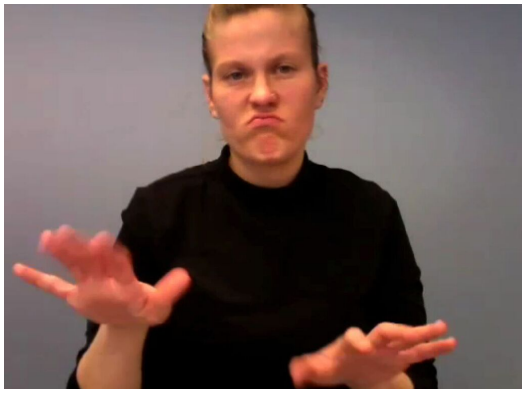


USE



WANT

WATCH



DON'T-WANT

WRAP

Appendix E: Gloss index for noncanonical verb types with reordering morphology

BRING{spatial]

DROP-IN-SLOT[handling]